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METAL INDUSTRY

THE JOURNAL OF NON-FERROUS METALS

VOL 94 No 17

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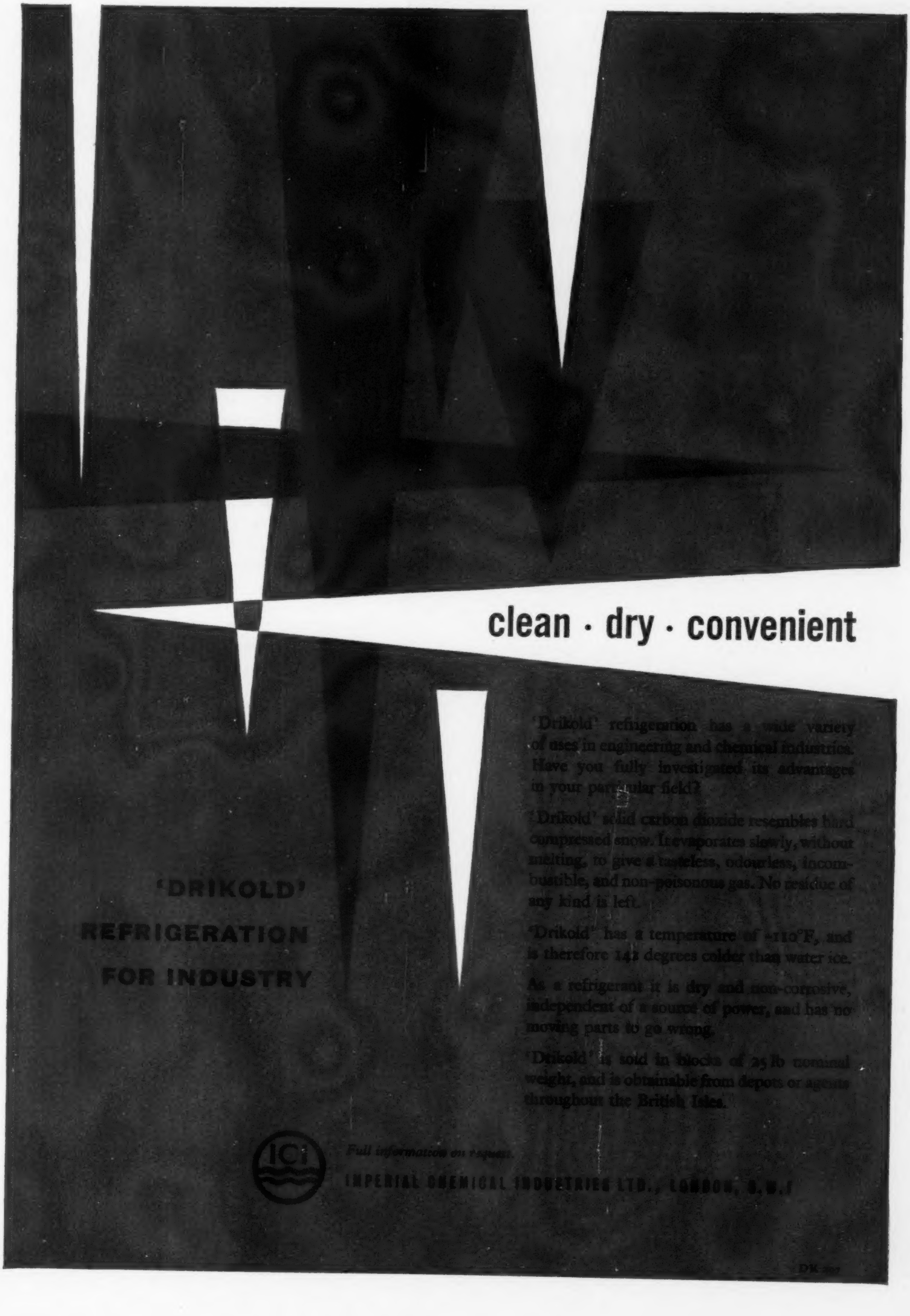
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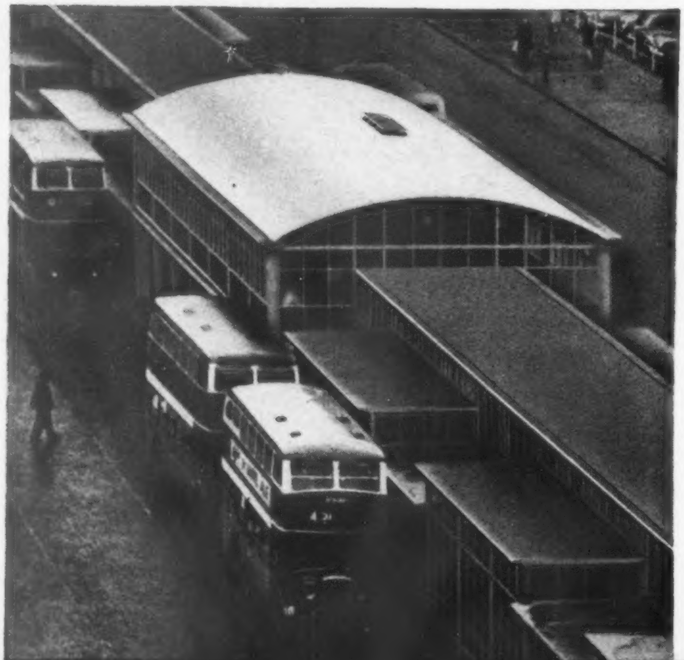

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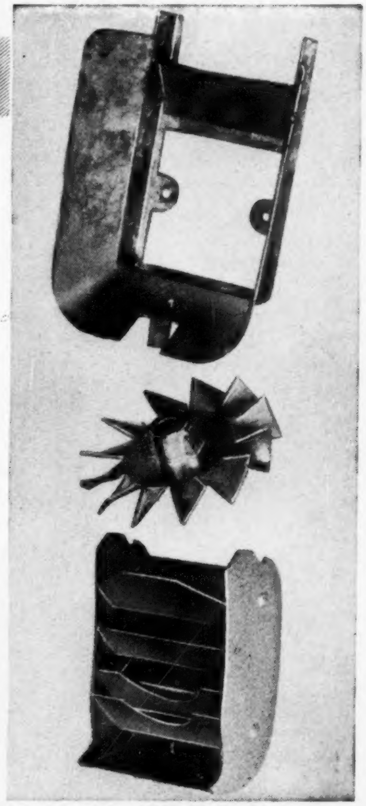

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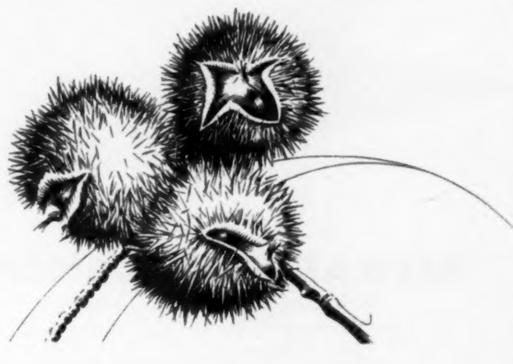

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METAL INDUSTRY

FOUNDED 1909

EDITOR: L. G. BERESFORD, B.Sc., F.I.M.

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METAL INDUSTRY

VOLUME 94 NUMBER 17 24 APRIL 1959

Russian Zinc

THIRTY years ago the output of zinc in Russia was only 3,000 tons a year, by 1938 a yearly output of 75,000 tons had been reached, and last year it was probably between 300,000 and 350,000 tons. In general, zinc is found in association with lead but in the Urals zinc-copper ores are mined, nearly one-quarter of all zinc ores being obtained by open-cast mining. There have been striking developments in mine production since the war, and Russia claims to have the largest proved resources of zinc and lead in the world. In addition, the U.S.S.R. imports about 100,000 tons a year of concentrates from North Korea.

Comparing the Russian industry with that in the West, Mr. R. Lewis Stubbs, Director of the Zinc Development Association, in a Paper presented to the American Zinc Institute, states that nearly all production comes from comparatively new electrolytic plants of standard design. The processes are well understood but the plants have few novel features. The complexity of the ores makes recovery difficult, and metal recovery and also productivity are not as high as in the West. The most impressive feature of the Soviet industry is the amount of research being conducted on methods of production, much competent work having been done on fluo-solid roasting, the treatment of complex ores, and continuous casting techniques. At present the electrothermic process is being examined for possible use in special circumstances, but the electrolytic process has been standardized even where power has to be generated from coal.

Zinc fabrication is not so advanced as in the West, although consumption in 1958 was in excess of 330,000 tons and, in addition, some semi-fabricated zinc was imported from Poland. Brass and galvanizing are the main uses, although there are no continuous strip galvanizing lines. Zinc oxide is also important since it is the principal white pigment for paints, little titanium dioxide being, as yet, available. Die-casting, which is carried out mainly by automobile manufacturers, is comparatively undeveloped, and special high-grade zinc is not obtainable. Sheet zinc does not appear to be used in the building industry.

Russia, an importer and exporter of zinc metal, is said by Russian experts to be a net importer but, as Mr. Stubbs emphasized, the available figures do not bear this out. It is suggested, however, that exports to the West have been made solely to earn foreign currency. Within the Communist bloc there is much trade in zinc. Imports of zinc metal from Poland were about 50,000 tons in 1955 and 1956, and lower in 1957 and 1958. Soviet exports made at world prices, however, expanded from 35,000 tons in 1955 to 72,000 tons in 1957, being somewhat less in 1958. An increasing proportion has been going to the West, which received 40,000 tons in 1957 compared with 15,000 tons in 1955. Some concentrates were also sent to Western Europe last year.

Are these exports likely to grow in future? As Mr. Stubbs pointed out, no definite answer can be given to this question since the complete control exercised over production and consumption makes it simple to send temporary surpluses, or, indeed, to divert supplies, to foreign markets. All signs point, however, to a tremendous increase in Russian home needs, since the new Seven Year Plan aims at raising Russian standards to the present level in the U.S.A. As the Plan only provides for increasing zinc production by 60 per cent in the period, it is likely that consumption will rise more than production and Russia become a bigger importer of zinc. On the other hand, as new plants come into operation, temporary surpluses might continue to occur and be exported to obtain foreign currency.

Out of the MELTING POT

Further Addition

UNTIL sufficient experimental facts have been collected to add up to a comprehensive explanation of the phenomenon of fatigue in metals, isolated results still give rise to explanations that tend to give the impression of being more trouble than they are worth. For example, there is no disputing that dislocation mechanisms are undoubtedly involved in the fatigue behaviour of metals, but likewise there can be little doubt that, for the present, such mechanisms tend to get "lost" once they reach the surface of a part being subjected to fatigue stressing. There are explanations that emphasize, and probably over-emphasize, the influence of the chemical interaction of the surface with the surrounding medium or certain of its constituents. Then, again, there are the explanations in terms of physico-chemical concepts. Resort is made to these concepts in connection with the effect of surface active media on fatigue strength. They have been used to explain, for example, the observation that the presence of weakly surface active media (e.g. various oils) in contact with work hardening metals being subjected to cyclic stressing, has the effect of lowering the fatigue strength below the value shown by the metal when tested in air. They have also been used more recently to explain the beneficial effect of strongly surface active media (e.g. molten tin and lead-tin alloys) on the fatigue strength of work hardening metals subjected to cyclic deformation. The horizontal portions of the S/N curves obtained in rotating bend fatigue tests on notched, carbon-steel test-pieces tested at 300°C. in molten tin or tin alloy, were found to lie above those of test-pieces tested in air at the same temperature, test-pieces which had been given a preliminary tinning being superior in this respect to test-pieces which were tested in the molten metal without any preliminary tinning. In addition to the effect of surface activity, it is suggested that the behaviour observed may, in part, be due to a "healing" effect of the molten metal on the notch and to the protection against oxidation it affords to the root of the notch.

Robbed

EVEN leaving science fiction out of it for the moment, quite a good argument can be advanced to the effect that the modern tendency of jumping ahead is undesirable. To begin with, too much of this looking ahead is liable to lead to some neglect of the present and of its opportunities. A glance at the past will show all sorts of fields of human endeavour littered with opportunities that were left unused, or that were not used to the full, because of the hurry to get on with something new. Living in imagination one or two jumps ahead of the present might be claimed to have the advantage of creating some measure of discontent with things as they are at present, and thus providing an urge to press on to something better. In actual fact, this preoccupation with the future leads merely to a neglect of the present. A real discontent can only arise from a close acquaintance with the existing state of affairs, for which acquaintance this pre-occupation with the future leaves less and less time. Jumping ahead not only leads to a neglect of the present, but it also tends to rob future developments of the appreciation which they would otherwise receive. Instead, they are merely taken for granted. Had it not been for science fiction and other less extreme forms of anticipation, the launching of the various satellites would surely have received much more interest, whereas, as things are, they have at once been taken for granted, the landing of "space men" on the moon already being expected as a fairly certain next step. We thus find ourselves the poorer for being robbed both of an interest in the present and of an appreciation of coming developments almost before they have been realized. It is in this situation that an explanation of the current lack of interest—so often deplored—in the progress of science might be sought. How wistfully does one look back from it to the tremendous zest and enthusiasm of the nineteenth century for scientific and technical achievements before the rot began to set in with Jules Verne and other less and more imaginative scribes of that ilk.

Concentration

PENETRATION of molten metal into a crack is of interest in connection with the healing of cracks formed as a result of hot-shortness of a cast metal, and in connection with the movement of the residual melt in the capillary channels formed in the solidifying portion of an ingot. It is, of course, also of considerable interest in connection with welding. It has been shown that the concentration of dissolved elements in metal which has penetrated into a crack may considerably exceed their concentration in the bulk of the molten metal, both in the case of equilibrium and in the case of non-equilibrium (solidification) co-existence of the solid and liquid phases. In more recent experiments, quantitative determinations have been made of the changes in composition of a melt penetrating into a crack. The melts consisted of pure aluminium-copper (2·9, 7·8 and 26·0 per cent) and aluminium-zinc (4·9 and 15·0 per cent). The molten alloy, at a temperature 5° to 10° above its solidus, was contained in a crucible, across the top of which was placed a bar of pure aluminium (4×6 mm. in cross-section), the bottom side of which was in contact with the surface of the melt. A special scraper was used to remove oxide films and ensure wetting of the surface of the bar by the melt. Using a round-nosed punch, the bar was then bent down into the melt, whereupon a number of cracks formed in the stretched face of the bar. The formation of these cracks could be facilitated by transverse scratches. The contents of the crucible and the bar were then rapidly quenched, the whole experiment taking only about one minute. Cross-sections were then made through the solidified composite specimens, and the composition of the melt which had penetrated into the cracks was determined by a micro-radiographic method. It was found that the copper alloy (in the case of the 2·9 and 7·8 per cent copper melts) which had penetrated into the cracks had a composition approximating to that of the aluminium-copper eutectic (33 per cent copper). This was confirmed by microscopic examination, which showed that the alloy in the crack had a eutectic structure. It is interesting to note that the tendency for cracks to form in the bent bar diminished with increasing copper and zinc contents of the melt. Only after providing a deep scratch could a crack be made to form when using the melt containing 26 per cent copper.

Skimmer

[Courtesy Barrow Haematite Steel Co. Ltd.

Ingot Moulds

By J. C. WRIGHT, Ph.D.

DURING the discussion on an important Paper[1] dealing with ingot mould technology in 1932, an authoritative speaker declared: "I believe that the iron mould will become, or rather is, as obsolete as the old stone mould of the 18th century. Real progress will be made only by getting right away from iron of all types and the brass trade will do well to turn its attention entirely to copper moulds". More than a quarter of a century has passed. Direct chill methods of ingot casting have, meanwhile, been developed on a substantial scale though primarily for light alloys. The use of water-cooled copper ingot moulds has spread considerably but neither of these processes has completely ousted the solid ingot mould. Indeed, there are important alloy groups where water-cooled ingot moulds have been tried but casting has reverted once again to solid cast iron moulds. In defence of the speaker quoted above, it must be remembered that the state of development of solid cast iron ingot moulds at that time was not particularly advanced. A further contributor pointed out that "it is well known that there is no correlation between mould life and composition for (cast iron) ingot moulds, and this explains the range of compositions used in ingot mould practice". Because cast iron moulds have been further developed since the date of these statements it would be difficult to claim now that mould life cannot be correlated to some extent with composition. Unfortunately, the amount of recent fundamental work on cast iron moulds is not very great and a wide variety of irons is still used for ingot moulds; some of them certainly do not measure up to the best that can be achieved.

In batch methods of ingot casting, the moulds, with which this review is concerned, not only form the shape and size of the ingot but they influence the state of the ingot surface, and the soundness and macrostructure of the ingot. The extent of these influences depends on the type of mould, its design and the materials used in constructing the mould.

Mould Types

There are two broad classifications for batch type ingot moulds; solid and water-cooled moulds. Both classes may be subdivided into one-piece or two-part moulds, and these classes may be further subdivided into categories describing mainly the shape of the mould or of the ingot it produces; such as cannon moulds, strip moulds, horizontal cake moulds, pig moulds, wire bar moulds, and so on.

When a round ingot or billet is cast, the solid mould may consist of one piece and is normally referred to as a cannon mould. The mould usually consists of a heavy wall tube, slightly tapered in the bore and open at the bottom, but in service it either rests squarely on a bottom plate or is fitted with a plug. Alternatively, the mould may be split longitudinally in two halves which are clamped tightly together when the mould is ready for receiving the ingot metal. No taper is needed in this case and the bottom plug is integral with one of the halves, so no separate base is required. The two halves may hinge on each other, one side opening from the other either downwards or sideways. If a round mould is of the water-cooled type, it is rarely split and consists of a water-cooled tapered tube of the order of $\frac{3}{8}$ in. thick; the outside of the water jacket being substantially heavier in section and usually either cast iron or steel.

If the height of a billet is greater than about twice its diameter it is rarely the practice to arrange heat extraction through the base of a batch casting mould more efficiently than through the walls, in spite of the fact that this would improve the unidirectional solidification of the billet. In casting flat cakes, however, it is common practice to extract most of the heat through the bottom of the mould, using water-cooling if necessary, and to discount the effect of the mould walls.

Vertical moulds for casting slabs are usually of the split type, both solid and water-cooled, to facilitate stripping, cleaning and dressing the mould. For vertical casting small sized slabs and strip stock, one half of the solid type mould carries the narrow sides of the mould and the bottom piece. The other half is, in effect, a lid and the halves are held together by screw clamps, hooks, rings and wedges, or similar devices. Larger vertical moulds are almost invariably split but usually hinged to limit the effort required in handling. Mostly, the water-cooled

types are hinged to open like a book and the hinges may carry the water supply to and from one or both halves of the mould. The solid large slab mould can also be a book type mould or it may be hinged at the bottom and, with one half fixed to the wall of the casting pit for instance, the front half can be unlocked and lowered forwards and downwards to gain access to the mould cavity.

Most other types of moulds are variations on the ones described above. Wire bar moulds produce a casting which is relatively small in cross-section compared with its length. They may be cast horizontally in open top moulds or vertically, singly, or in multiple units. Pig moulds are open top horizontal moulds akin to horizontal wire bar moulds and to slab moulds.

Cast Iron Moulds

Cast iron is the major material for solid type ingot moulds because it is not very prone to warping during casting operations; it resists ingot metal adhesion reasonably well, possesses high heat capacity, is easily founded, machined, and is relatively cheap. Its disadvantages can be serious ones and they require detailed explanation.

Cast iron moulds can suffer from two types of cracking, major cracking and "crazing" cracks. Major cracking of cast iron moulds is generally the result of inferior mould design involving incorrect section thicknesses, unduly sharp corners, or internal stresses in the mould as cast which are added to the thermally induced stresses the mould develops under operating conditions. Such internal stresses can be minimized by careful design, good foundry practice on the part of the mould supplier, and they can be eliminated by annealing the ingot mould before putting it into service. An iron containing more than an absolute minimum of phosphorus and sulphur will tend to be more prone to major cracking than a high quality iron in the same circumstances. It is also necessary to control the degree of whiteness of the iron because a white or a mottled iron will not withstand the thermal stresses inherent in the work of a mould as well as a grey iron. With careful attention to iron quality, mould design and manufacture, major cracking failures of moulds are rare.

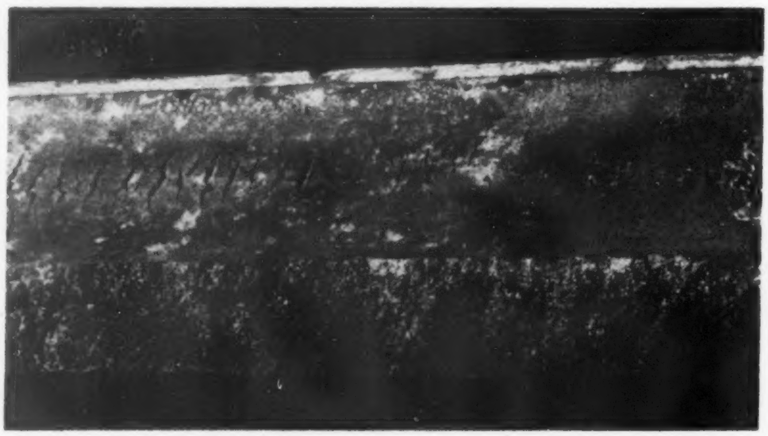
"Crazing" is very much more difficult to avoid and ultimately a cast iron ingot mould working under fairly arduous conditions, receiving molten metal at temperatures of 1,000°C. or more, will probably show a crazing defect. In the early stages of its development, this defect appears as a network of fine cracks on the working faces of the mould. Some of the cracks widen and deepen as the number of casts made from the mould is increased until the mould has to be withdrawn from service. Surface deterioration of the mould not only shortens its useful life but it increases the difficulty of producing consistently good ingots. The first fine cracks which form can be covered easily by a well applied mould dressing but as the cracks develop they tend to retain the dressing together with moisture and gases. Thus, defects are formed on and just below the surface of the ingot. Actual measurements show that the porosity in brass ingots towards the end of the mould life is about twice that from new moulds.[2] When the cracking has developed still further, the ingot metal itself can penetrate and freeze in the crack. At best this will cause severe deterioration in surface quality and if the fins so formed are sufficiently strong, they may cause hot tears by restricting solidification contraction. In any case, removal of a cold ingot from a one-piece mould in this advanced state of deterioration will be almost impossible and from a two part mould may be difficult.

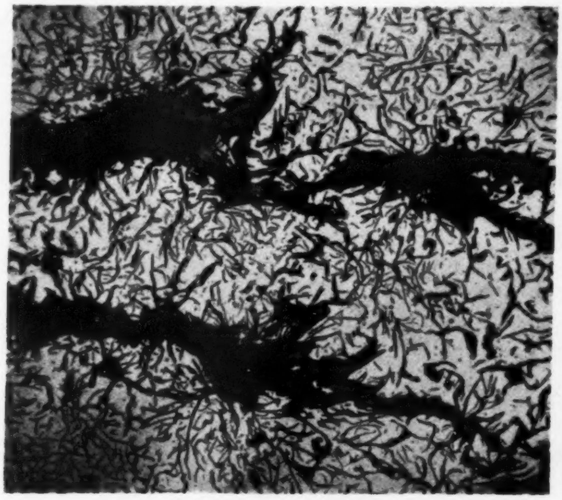
The mechanism of mould crazing frequently depends on several factors. As molten metal is poured into a relatively cool ingot mould, the working surfaces are suddenly heated to a temperature of several hundreds of degrees centigrade. If the molten metal stream impinges on the mould wall for any length of time, the temperature of the mould surface will approach the melting point of the ingot metal. Since the flow of heat through the subsurface layers of the mould must take a finite time, a steep temperature-gradient is developed. The working surfaces tend to expand but are restricted by the cooler sublayers, resulting in severe compressive forces. Cast iron resists compressive forces very well but at the working temperature of the mould local deformation of the surface may be sufficient to induce cracking. In any case some permanent deformation will occur and when the mould cools subsequently, the deformed inner surface will be subjected to tensional forces. This thermal fatigue mechanism would be sufficient to start and propagate crazing, but there are other mechanisms which support it. For instance, a further sudden and large change in volume is associated with the ferrite to austenite transformation at about 730°C. The surface layers will undergo this transformation on heating earlier than the inner layers and this adds to the differential expansion difficulties. A further source of stress is the inherent instability of the carbide present in cast irons. In the presence of sufficient graphitizing elements such as silicon and at temperatures commonly encountered in mould service cementite tends to decompose into ferrite and graphite whose total volumes exceed that of the original cementite. This is the basis of the process known as "growth" of cast iron and is possible at or near the working surface of the mould. At the same time as growth is taking place the matrix appears to be more vulnerable to oxidation and this creates another tendency to expansion and the matrix also becomes embrittled.

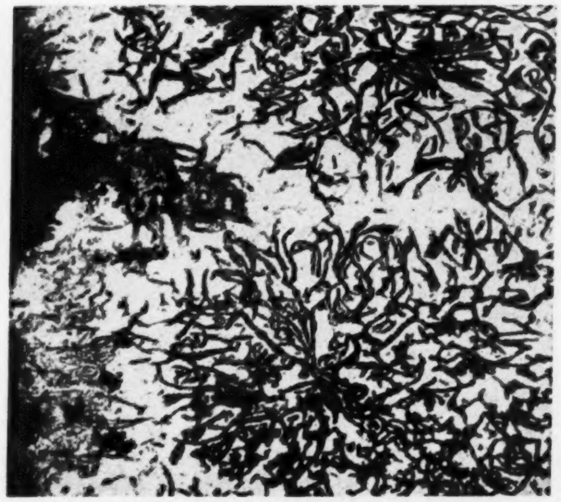
Some of the details of a mould cracking failure are shown in Figs. 1-4. The general branching nature of the crack system, its open nature and the degree of scaling in the crack are illustrated in Fig. 2, while Fig. 3, taken from a position very close to the working surfaces of the mould shows evidence of considerable decomposition of cementite into ferrite and graphite. Taken from a region about $\frac{3}{8}$ in. from the working surface, Fig. 4 shows a less affected structure. If Figs. 3 and 4 are compared, it will be seen that near the surface of the mould there is far more graphite and far less pearlite than is the case for the region further from the working surface.

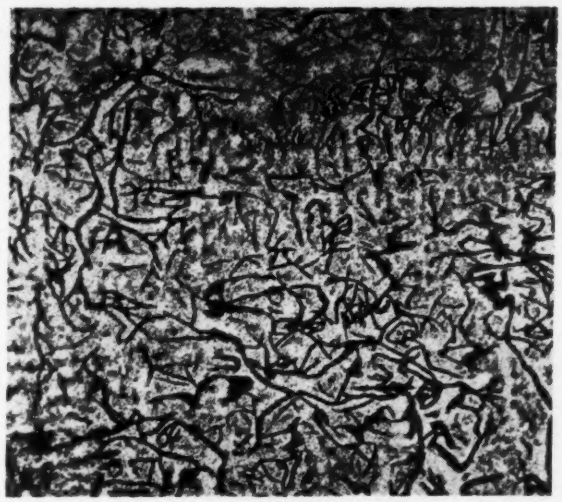
Of the mechanisms contributing to crazing of moulds, the most important initially is the thermal fatigue and differential stress mechanism. It is not feasible to alter the thermal coefficient of expansion of cast iron but the mechanical properties of the iron can be improved by careful choice of the composition of the iron and good foundry practice. The ferrite to austenite transformation cannot be influenced economically but it is possible to control graphitization and limit oxidation. The main aim is to use an iron which is not excessively brittle, so the sulphur and phosphorus must be held to a minimum, a moderate

Fig. 1—An example of severe crazing of a mould surface









Above left: Fig. 2—Wide, branching and scaled cracks. Unetched (×30)

Above right: Fig. 3—Area immediately below working face. Note lack of carbide and heavy graphite due to graphitization of carbide leading to "growth." Etched 2 per cent Nital (×100)

Right: Fig. 4—Area ¾ in. from working face. Note presence of pearlite and rather less graphite than in Fig. 3. Etched 2 per cent Nital (×100)

amount of pearlite can be present but the graphite distribution should be controlled. In order to prevent breakdown of pearlitic cementite under working conditions it is necessary to limit the amount of graphitizing elements present, particularly silicon, and sometimes to add carbide stabilizers. The amount of silicon present should be just sufficient to ensure that a given mould section shall be just grey.

This will also ensure oxidation resistance to some extent, in that the structure of the iron will be fine and close, with moderately sized graphite flakes well distributed. Such a structure will also tend to resist the erosive action of a molten ingot metal stream much better than an open grained iron. This particular combination of properties is most easily derived from the use of a hematite iron of suitable composition. This may then be cupola melted, possibly with steel scrap to achieve the wanted composition, but the emphasis should be on rapid melting to limit the sulphur and gas pick-up. Ingot mould founding has few special difficulties but it is necessary to provide very adequate feeding to all ingot mould sections because microshrinkage and major shrinkage not only weaken a mould from a hot strength point of view but also open it up to oxidation attack. The working surface of a mould should be smooth, fine grained and cast as accurately to final dimensions as possible to avoid major machining operations. It is, in fact, frequently disadvantageous to machine off the as-cast surface because a machined surface, although smooth and accurate, will not always resist wetting by molten ingot metal nor oxidation attack as well as a good as-cast surface. With some moulds it is impossible to produce an as-cast working surface sufficiently accurately to serve. Machining is then inevitable. If a mould requires refurbishing after some service, machining is then bound to remove the as-cast skin. In order to rely on the cast surface, the working cavity of the mould must be formed against first quality cores. The control of surface and dimensions inherent in the CO_2 core process make this a very suitable method for forming the mould cavity.

Further improvement in the life of cast iron moulds can be attained by a suitable annealing treatment before putting the mould into operation. During this treatment, some of the cementite may decompose, but stress relief can take place uniformly and there is less likelihood of further extensive carbide decomposition in service.

One further difficulty may be encountered when using cast iron as a mould material. At temperatures which it might well reach in service in casting high melting point alloys, carbon in cast iron is capable of reacting with sources of oxygen to form carbon monoxide, which, generated at the mould face, may be forced into the partly solidified ingot. The surface of cast iron moulds becomes oxidized in service, and below this scale there is cementite.

During pouring, the temperature of these constituents can rise to over 700°C., when the cementite can reduce the oxide; $Fe_3C + FeO = CO + 4\,Fe$. Oxygen can arise from sources other than mould scale, such as mould atmosphere or from unstable metal oxides associated with the ingot metal. Since graphite is far less reactive in the "mould reaction" or "blowing" than is cementite, it might be assumed that elimination of cementite from the mould material would overcome this trouble. While this is largely true, it is not feasible to produce a mould iron cheaply and at the same time to ensure that it will withstand service stresses without relying on some pearlite in the mould iron. Here, again, attention to the composition of the mould material helps in overcoming the blowing reaction. Stabilized carbides are far more difficult to break down in reactions with oxide than are carbides which are not stable. Much the same considerations apply here as apply in the stabilization of carbides against graphitization. Additionally, it is possible to coat the mould with a substance whose oxide is much more stable than the oxides of carbon. This

will tend to reduce the oxygen carrier preferentially, and blowing due to the carbon oxide gases will be prevented. Such a material, aluminium is a good example, can be incorporated in the standard mould material. Standard mould dressings, particularly reducing volatile ones, also help to overcome mould reaction by insulating the mould surface to some extent and by preventing oxide build-up. Mould reaction often shows up, particularly in areas of ingot metal stream impingement, so if such impingement is avoided by good casting pit practice, the incidence of blowing will be curtailed.

Copper Moulds

The thermal conductivity of copper is about twelve times that of cast iron and, what is more pertinent, the temperature diffusivity of copper is also about twelve times that of cast iron. Copper is far less brittle than cast iron, strongly resists thermal shock, and undergoes no phase transformations in the solid state. Neither is it involved in gas producing reactions which might give rise to blowing.

The disadvantages of copper are that it is wetted by molten metals far more than is cast iron, its surface is easily damaged and the mould distorted due to its softness, particularly at casting temperatures. On a weight for weight basis, copper is very much more expensive than cast iron, and this leads to appreciable capital being tied up in solid moulds even though the scrap value is also high.

These disadvantages are reduced to a large extent if the use of copper is confined to the working faces of the mould and backed by a cooling water-jacket. Here the copper is held at a temperature low enough to discourage adhesion of the molten ingot metal. Rather less capital is tied up in such moulds than is the case for solid copper moulds. The copper face plates can be replaced, when required, independently of the rest of the mould structure and fittings.

Miscellaneous Materials

Moulds machined from high quality dense graphite have good thermal shock resistance and are wetted by very few metals. Unfortunately, graphite will not stand up to the rough handling which ingot moulds may receive in a production shop. Graphite also oxidizes rapidly in air at temperatures which would inevitably result from casting high temperature metals. Graphite moulds are generally restricted in use to special operations and laboratory work.

The main reason for not using steel in making up the working surface of an ingot mould is that it is liable to warp under operating conditions. It is also sensitive to adhesion of some molten ingot metals. The warping is caused by the same stress system which causes crazing in cast iron moulds but, unlike cast iron, the stresses are not relieved by cracking.

Aluminium has a place as a mould material for low melting point alloys, but for general purposes its use is limited by its low melting point and softness at moderate temperatures.

Summarizing the effect of the properties of the various materials on their use in ingot mould construction, grey cast iron is almost invariably chosen for moulds for casting remelt ingots because surface quality is not very important. Solid moulds are normally made from carefully chosen grey iron, and some of its disadvantages are offset by the ease of manufacture and cheapness, particularly for moulds of a wide variety of shapes and sizes. The working faces of water-cooled moulds are normally of copper. There are a few instances when copper is used in solid moulds. For instance, high conductivity copper is used for making wire bar moulds to cast high conductivity copper. As soon as they deteriorate in any way, the moulds are withdrawn and remelted. Since they are simple to produce initially, this method is not costly within a copper producing plant.

References

[1] G. L. Bailey, *J. Inst. Met.*, 1932, **49**, 203.

[2] M. Cook & N. F. Fletcher; *J. Inst. Met.*, 1948-49, **75**, 353.

(To be concluded)

ARC AND INDUCTION MELTING PLANT AT JESSOP-SAVILLE

Vacuum Melting Special Alloys

VACUUM melting will not satisfy all the demands made by the engineer, but it does represent a considerable advance in many metallurgical problems, and in steel melting, as well as the newer non-ferrous alloys, the process has shown advantages.

Turbine and compressor disc materials used in gas turbine aircraft engines must be virtually free from non-metallic inclusions. Vacuum melting can not only ensure this, but also provides the designer with enlarged scope for even more highly stressed conditions. This freedom from non-metallic inclusions also ensures that the transverse ductility of forged discs is improved. Tensile tests on vacuum melted 12 per cent chromium steel discs have, for instance, given elongation values four times greater than those obtained on discs made from air melted material.

Induction vacuum melting has made possible the production of alloys which, because they contained elements which readily oxidized, could not be produced by conventional air melting methods. This new technique now opens up fresh fields in the development of high temperature materials. One such alloy, Jessop G.64, contains high percentages of aluminium and titanium, and can only be made satisfactorily in a vacuum melting furnace. It has excellent high temperature properties, and is being assessed for stator and turbine blade applications.

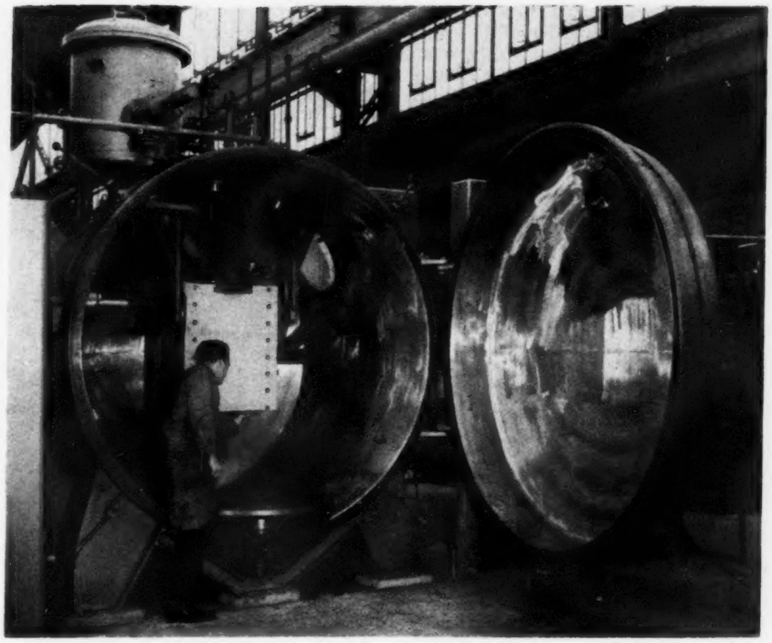
The advent of nuclear power plants has posed further problems for the metallurgist in the demand for new materials. One of these is zirconium, which can only be produced by vacuum melting.

With increasing demand for titanium and zirconium, the existing vacuum melting plant at Jessop-Saville Ltd., Sheffield, could not satisfy all requirements, particularly for the larger forgings, and the decision was made to increase production facilities. A new Heraeus consumable arc melting furnace has now been installed and is fully operational. This is capable of melting titanium ingots up to 24 in. diameter and in excess of $2\frac{1}{2}$ tons in weight. Also recently installed and fully operational is a new 600 lb. Wild Barfield/N.R.C. high-frequency induction melting furnace. Each of these furnaces is of the largest type in this country and in combination provide the largest operational vacuum melting plant outside America.

Induction Melting

The Wild-Barfield/N.R.C. 600 lb. vacuum induction melting unit at Jessop-Saville Limited is designed for semi-continuous operation, provision being made to accommodate sufficient ingot moulds for several heats on the rotary mould table, and for charging the furnace through a bulk charging hopper without breaking the vacuum in the melting chamber.

The principal unit of this installation is a horizontal vacuum chamber constructed of stainless steel, approximately $7\frac{1}{2}$ ft. in diameter by 9 ft. long. The end of this chamber is sealed by a hinged door, and the whole of the chamber and door is water-cooled by copper coils, brazed to the outside of the unit. This chamber contains the high frequency induction melting coil which is designed to tilt about the pouring axis and immediately in front of and below the furnace there is a rotary mould table which allows several ingot moulds or castings to be poured from one melt. Provision is made for the observation of all stages



The Wild-Barfield/NRC 600 lb. vacuum induction melting unit

of the process through three observation windows, each equipped with shields and wipers.

External controls are provided for the following operations: (1) Bridge breaker for breaking top layer of unmelted metal in the crucible. (2) Immersion thermocouple pyrometer for temperature measurement. (3) Sampling device which can be extracted through an air lock without breaking the main tank vacuum for compositional control during melting. (4) Sighting tube for optical pyrometer readings. (5) Internal light assembly for illumination of the tank interior.

A cylindrical chamber, situated on top of the horizontal melting chamber contains the alloy charging mechanism, consisting of a 2,200 in^3 bulk charging hopper, holding 300 lb. of material, and four smaller hoppers each of 90 in^3 and holding a further 12 lb. of alloys each. Both bulk charge and alloys are delivered to the crucible by a vibrating feeder through a 6 in. diameter vacuum lock. Alloy buckets are individually tripped by solenoids operated from the control panel. The vibrator feeds into a chute which swings over the crucible and an interlock is provided which prevents the vibrator from operating unless the chute is in position The whole of this chamber may be refilled without breaking the vacuum in the main tank by closing the 6 in. diameter vacuum lock. A special pumping line is provided to evacuate this chamber after it has been recharged with material.

The pumping system is designed to handle the gases from 600 lb. molten charge during melting, purifying and alloying. The pumps have the necessary capacity for disposal of the gases as they are given off from the melt. Pneumatic operation is provided for all the vacuum valves used during the pumping cycle. The vacuum system consists of a large 16 in. diameter high vacuum manifold and a 6 in. diameter rough pumping line connected to the end face of the melting chamber to enable rapid and complete evacuation of the chamber. This combined system will pump the furnace chamber from atmospheric pressure to a pressure of one micron Hg in 15 min.

Vacuum gauges measure the furnace tank pressure from 1 micron to atmospheric pressure.

Operating platforms are provided for easy access to the controls and observation windows. The control panel for electrical and pumping systems is mounted on the main operation platform.

The power supply for the melting is a 200 kW motor alternator set working at 400 V and 3,000 cycles/sec.

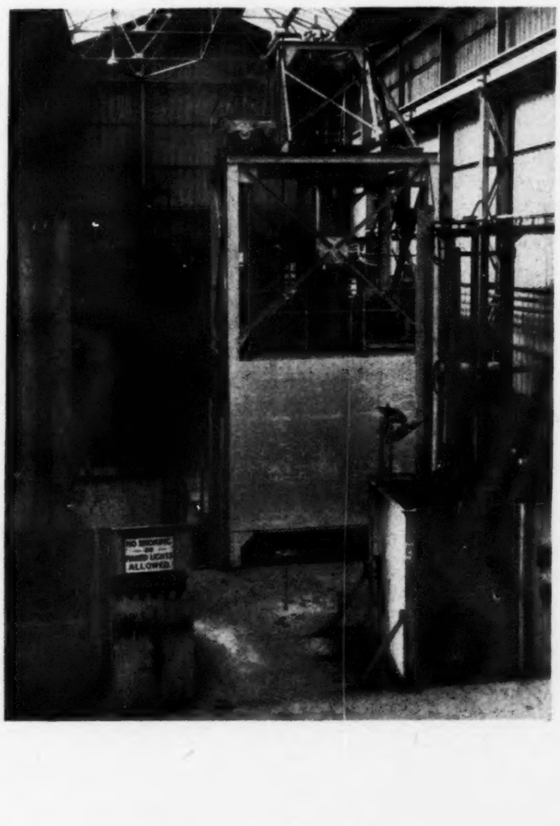
The furnace will be used for melting iron-, nickel- and cobalt-base alloys.

Arc Melting

The Heraeus consumable arc-melting furnace consists of a large vacuum-tight vessel evacuated by pumps, which are capable of handling large volumes of gas at high vacuum. The actual melting is carried out in the copper crucible which forms the lower half of the furnace.

An electrode is placed inside the furnace, where it is welded on to the feeder rod, under high vacuum conditions. The electrode can then be driven up or down, to control the melt, by applying drive to the feeder rod. This feeder rod also carries the melting current, through sliding vacuum seals, from the electrical busbars down to the electrode.

The melt is started by striking an arc between the bottom of the electrode and a small charge placed at the bottom of the crucible. The heat



The Heraeus consumable arc-melting furnace

generated by the arc provides sufficient heat to melt the tip of the electrode. Molten metal sprays down to form a pool, which, when solidified, forms the ingot. As the molten pool is only of small dimensions, great care must be taken to ensure that melting conditions are kept constant throughout the melt.

A view of the melt is projected on to the melting desk alongside the many electrical gauges. From these, the melting operator is able to assess the furnace conditions and make any necessary modifications to control the melting to a rigid specification.

The furnace components — pumps, valves, etc.—are actuated remotely from a control cabinet. There is provision for automatic operation of all vacuum equipment so that, when the furnace is closed, evacuation is taken through all its stages entirely without supervision. This automatic system also safeguards the vacuum equipment in cases of component failure. For safety, the arc current is interlocked to all operations which, if faulty, could lead to dangerous conditions. A section of the cabinet is given entirely to indication of possible breakdowns so that rapid rectification can be made.

An electrical control unit drives the feeder rod as required by the melt. Arc gaps can be maintained within fine limits when using this unit at maximum sensitivity, and it is possible to apply a current of 18,000 amps to the electrode.

The vacuum equipment is capable of holding melting pressures below 1 micron. In this pressure range, the arc is very stable. There are two pumps fitted for the final evacuation of the furnace, a Roots and a booster pump. Their combined speeds are 4,000 L/sec. for air and 10,000 L/sec. for hydrogen.

Titanium ingots range from 9 in. dia. —120-420 lb. — through sizes 12 in., 16 in., 20 in. dia. to 24 in. dia., exceeding 2½ tons in weight. The plant is capable of producing zirconium ingots, but it is likely that initial production will be confined to ingots up to 800 lb. in weight. Steel ingots up to approximately 3 tons in weight can also be produced in the same sizes.

Pressure Die-Casting Review

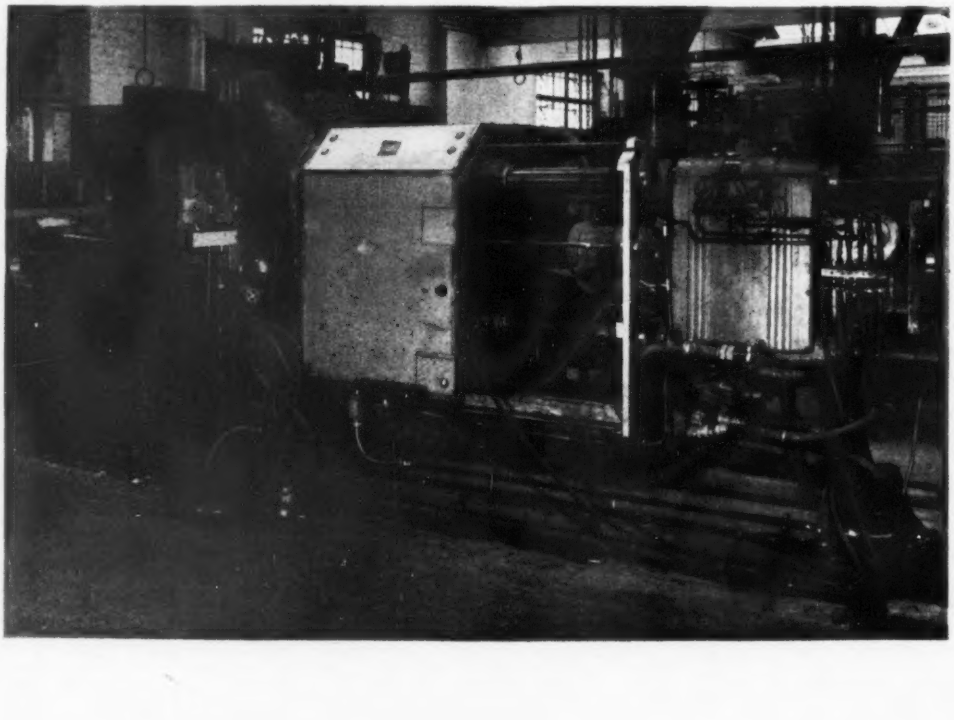
Guarding Die-Casting Machines

IMPROVEMENTS IN AIR AND HYDRAULIC CIRCUIT INTERLOCKS

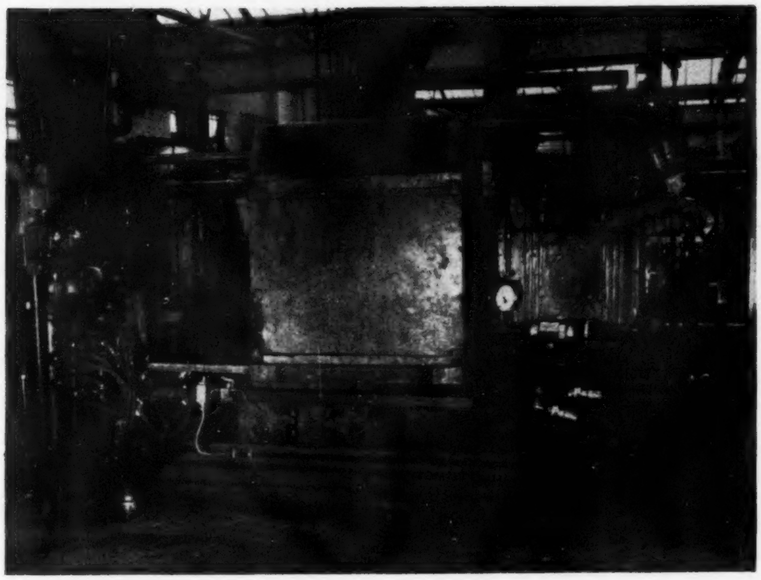
ALL die-casters will recognize the shortcomings of the manually-operated guard frequently fitted, in one form or another, to die-casting machines. The dependence of cycling time on the operator, the additional hazards accompanying hand-operation, all tend to encourage developments in automatic operation. So far, although a number of fully-automatic guards have been devised, an entirely satisfactory device has not been developed, and many die-casters, as well as guard designers, have turned their attention towards improving existing models.

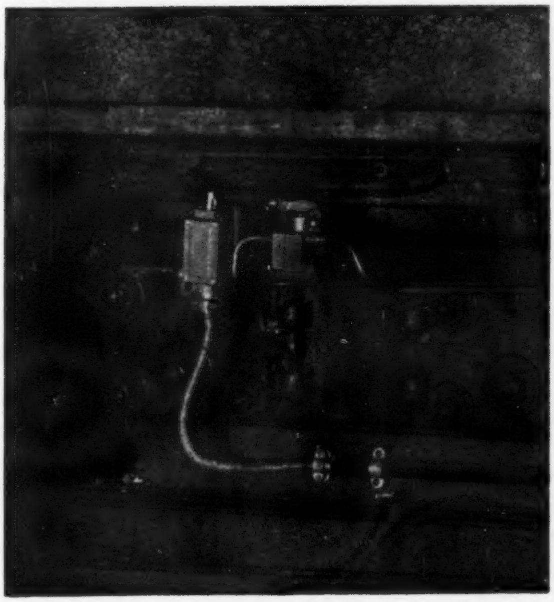
One of the most recent efforts in this direction, has been successfully concluded by Charles Hill and Co. Ltd., of Cateswell Road, Hall Green, Birmingham, who are manufacturers of a wide range of pressure die-castings under first class conditions in one of the most modern factories of its kind. Their particular accomplishment has been in the modification of a hand-operated guard on a Schultz die-caster, to a fully-automatic interlocked device that provides safe and simple operation; the cost of the conversion being very low—in the region of £5. The conversion of this guard proved so inexpensive and simple, and the guard operation was so successful that similar modifications were planned for the automatic guards on other machines. Here again, the conversion has achieved speedier, safer and simpler operation with little conversion cost.

The modifications involved affect the guard structure hardly at all. In both the hand-operated Broughton guard (the first to be converted) and the Highwood automatic guard, the guard panels are carried on two rails each of which is set above and at either side of the machine platens, two further rails at the lower edge of the guard serving as guides and supports only. Thus far the guards remain as before, the modifications that have been introduced affecting primarily the air and hydraulic circuits, as will be appreciated from the following description of the operating sequence.



The Broughton guard in the closed position. The limit switch can be seen at the lower edge of the guard, in contact with the operating plate on the guard itself. Air supply lines to the guard operating cylinders are visible leading from the right-hand side of the guard frame





Above: The Highwood guard in the open position

Left: Close-up view of the guard closed limit switch arrangement, showing the operating plate on the guard frame

In the control cabinet of the machine three sets of solenoid valves are incorporated. Of these, one controls a pilot air supply to the hydraulics, a second operates the air supply for slow injection, and the third operates the fast injection.

As the electronics are initiated to start the machine cycling, the solenoid controlling the air supply to the machine hydraulics is energized and air is supplied to the system. Prior to any movement of the hydraulics, however, air is bled via a tapping from this line to the guard closing end of the guard air cylinder; the air supply to the 4-way hydraulics valve being restricted by a 3-way air pilot valve which opens only when the guard is closed. Thus no air passes to the 4-way hydraulics valve until the guard operating cylinder has operated and closed the guard. As the guard closes, an operating plate fitted to its lower edge opens the 3-way air pilot valve and allows air to flow via a pilot air cylinder to the 4-way hydraulics valve, and this in turn sets the platens in motion and the dies close. Thus the first step in the machine cycle is completed.

The next stage of the cycle is injection, but this cannot take place until the die closed limit switch has been operated. This switch is in series with the guard limit switch, so that injection cannot take place until both guard and dies are closed. After injection, the solenoid valve air supply to the hydraulics is reversed, releasing air to the opposite end of the guard air cylinder, and the dies and the guard open together. This completes the machine cycle.

The adjustable operating plate on the guard frame is one of the features in this system. This plate operates a 3-way pilot valve in the hydraulics air supply, and once the guard on closing has passed the die parting line the operation of die closing follows immediately. This device achieves roughly a half second reduction of cycling time. Further the simultaneous opening of the guard and dies after injection results in an additional reduction of one second in cycling time.

In all guard designs one of the considerations that has to be faced is that of the work involved before and after die change. In this case, the guard involves the minimum of stripping-down time and assembly, removal of the top rails only being necessary before the guard can be lifted off.

The chief value of this development lies in the facility it offers for the conversion of hand-operated guards to automatic operation, thus ensuring faster operation and greater safety with the minimum of complications in the interlocking systems. It further has advantages over most automatic guards, it being claimed that it provides less complicated and more consistent and positive operation.

Correspondence

Correspondence is invited on all subjects of interest to the non-ferrous metal industry. The Editor accepts no responsibility either for statements made or opinions expressed by correspondents whose letters appear in these columns

TO THE EDITOR OF METAL INDUSTRY

B.S.S.1400

SIR,—The editorial "B.S.S.1400," in your issue of 27 March, could have been stronger still in criticism. The present specification has gone along remarkably well, and there really does not appear to be any need for this "improved" B.S.S.1400.

We feel that quite a number of the amendments are prompted by ignorance of the effects of the impurities on the various alloys. We think a very interesting case of this is the maximum sulphur content of 0·05 per cent specified in the German DIN1705 specification. The B.N.F.M.R.A. exploded the need for such a low limit, and you will be aware that they felt that even up to 0·3 per cent sulphur could be allowed without deterioration of results.

We also feel that some of the limits specified call for a standard of chemistry which, at present, is not attainable.

Yours, etc.,
George MacDonald.

E. Chalmers and Co. Ltd.
Leith,
Edinburgh, 6.

INFORMAL DISCUSSION ORGANIZED BY THE INSTITUTE OF METALS

Protection and Packaging of Non-Ferrous Metals

(Continued from METAL INDUSTRY, 17 *April,* 1959)

STAINING and corrosion arising from the presence of water vapour or chemicals in packing materials and packages are common causes of complaint, and several of the speakers dealt with these problems at the recent conference on "The Economic Protection and Packaging of Non-Ferrous Metals in Storage and Transit." The extracts from the discussion appearing here are largely concerned with these phenomena.

DISCUSSION

H. G. Cole (Ministry of Supply):

Corrosion can be caused by vapours given off by the very packing materials that are used ostensibly to protect the parts inside. This is, therefore, an especially insidious form of corrosion. It is one which occurs particularly during long-term storage, and we have met it rather severely in the Services, because so many of our parts are made and then packed away for long-term storage, often in tropical climates.

There has been a survey recently by an inter-Service advisory committee on this corrosion by organic vapours, and a pamphlet ("Corrosion of Metals by Vapours from Organic Materials," H.M.S.O.) has been published by the Stationery Office. As an instance of the sort of vapour corrosion which can occur is a case investigated by the Chemical Inspectorate. Some delicate mechanisms made of cadmium plated steel were packed in a polythene bag which rested on a hair cushion impregnated with polyvinyl acetate. The whole was placed in a sort of cheese box made of glass fibre impregnated with polyester resin. Under damp storage conditions, unpolymerized styrene from the plasticizer in the glass fibre box softened the polythene and increased its water vapour permeability by a factor of 20, and the polyvinyl acetate on the hair hydrolyzed to give acetic acid, which also passed through the bag. Inside the bag was found an aqueous solution of 2 per cent acetic acid. The internal parts were, naturally, very heavily rusted. That is an example of what can happen when you use the latest scientific methods!

There are two common vapour phase inhibitors, and their efficacy depends on the quantity you have inside the package, the shape of the package, the distance from the vapour phase inhibitor of the object you are trying to protect, the humidity inside the package, the temperature, the ventilation of the package, the presence of corrosive substances such as chlorides, SO_2, or organic vapours, and whether those corrosive substances got there first or whether the vapour phase inhibitor got there first. These vapour phase inhibitors are liable to attack non-ferrous metals and, once again, whether they do or not can depend on all these variables. I am quite sure that if you have 100,000 identical steel parts in 100,000 identical packages, and you want to ship them from here to Australia in a known time under known climatic conditions, then by doing some tests you can find out how to make vapour phase inhibitors do the job, and they will do a first-class job. But it is quite a different matter to make any general recommendations. I do not think you can. Each case—using the word in both its senses—has got to be considered on its merits.

Mr. Heron (P.A.T.R.A.):

I do not think the speakers so far have said how it is, or why it is, they have eventually chosen a particular kind of pack or corrosion preventive material. If this has been by trial and error, or by sending out packages on actual journeys from one place to another, I would say that that is perhaps hardly the most economical way of doing it. Nowadays, experience enables us to design tests which can be carried out under controlled laboratory conditions to give us a very good idea of how packages and protective materials are going to behave in practice, both from the point of view of protection from mechanical damage and protection from climatic hazards.

Where made-up packages are concerned, for example, the tests to determine the protection provided against mechanical damage and those to indicate their resistance to climatic effects should be linked up one with the other, rather than investigating these two effects in two separate unconnected experiments. I am thinking of materials of the type that have already been mentioned, such as kraft union and polythene, as liners for cases to provide waterproofing properties. They may prove satisfactory enough provided they stay intact, but the possibility exists, if the package is subject to rough handling in the first place, that they could become damaged and therefore only offer reduced protection against the ingress of water. Similarly, if the package is, first of all, subjected to the effects of climatic hazards so that it becomes damp or wet due to rainfall or sea-spray, the strength properties of the package, particularly if made of fibreboard, can be considerably reduced so that subsequent rough handling would permit mechanical damage to occur to the contents.

The types of tests we carry out in our packaging enquiry department at P.A.T.R.A. are, first of all, directed to examining any sort of packaging material which may be used in contact with metals, to determine whether there are any deleterious materials in the paper or board that would be likely to increase the corrosive effects. Chlorides and sulphates have already been mentioned and, in addition, the *p*H value should be checked. Another property which should be investigated where certain non-ferrous metals are concerned is the reducible sulphur content of paper or board which could produce a tarnishing effect.

A particular example that we had some time ago was a copper alloy object which rather thoughtlessly had been packed in direct contact with some single-faced corrugated strawboard. There were distinct parallel lines of tarnishing all down the polished metal surface corresponding to the parallel lines of the fluting of the board where it had come into contact with it. Tests on that board to make sure it was free of such deleterious materials would have saved that damage occurring.

The possibilities of rain, condensation or salt spray from sea voyages causing damage to a package or its contents can be investigated in the laboratory by means of shower tests or salt spray tests in a spray booth — actually subjecting the package to the hazard concerned to determine whether sufficient protection has been provided for the contents.

Where vapour phase inhibitors or contact inhibitors in a package are concerned, our aim is to provide a waterproof, but not necessarily a water vapour-proof liner for the outer container. We are relying on the inhibitors to prevent corrosion of the metal surfaces even in the presence of high relative humidities. If we are relying on a dessicating material, however, such as silica gel, it is essential to keep the ingress of moisture vapour, as well as actual liquid water, into the pack as low as possible. Therefore, the water vapour permeability of materials such as kraft union, polythene, or other case lining materials, is of particular interest. The lower the water vapour permeability the better, because less moisture vapour can penetrate into the pack and require to be absorbed by the dessicating agent. We carry out a standard test in our laboratories for determining moisture vapour permeabilities of packaging materials. This is carried out using small aluminium dishes, in the bottoms of which a dessicating agent is placed. Specimens of known area of the test material are then sealed across the tops of the dishes, which are then stored for known intervals of time in humidity cabinets under controlled temperature and relative humidity conditions. Weighings at intervals determine the rate at which water vapour passes through the barrier material. A particular point which has to be remembered is whether creasing of the film or the adequacy of sealing have any effect in the way of allowing more moisture vapour to enter the package. It is no good having a material of extremely low water vapour permeability if that desirable property is lost on creasing the film or through the inadequate sealing of the material.

It is advisable whenever possible, therefore, to check up on your final package as such, with the appropriate contents inside, packed and sealed as would be the case in practice.

I have mentioned the possibility of carrying out shower tests; in other words, subjecting whole packages to a shower bath in the spray booth to see whether adequate protection has been achieved. The other type of test which we carry out in our routine package testing work on packages destined for export markets, is storage under humid conditions. We can carry out accelerated tests by means of storing packages under slightly more extreme conditions of temperature and humidity than would be met with in

practice. We believe that if a package is tested at a higher temperature than it will be subject to in practice, then a 10°F. increase in temperature approximately doubles the rate of deterioration of the contents of the pack. Similarly, another multiplication factor of two is introduced if the pack is stored at 10 per cent relative humidity higher than would be the case in practice.

We must also consider the more drastic effects of cycling conditions rather than steady conditions; that is, high temperature and humidity conditions alternating with low ones causing condensation inside and on the outside of the package. I would add a word of warning here, in that it is not advisable or recommended to attempt to accelerate storage tests of this nature by more than about 8-10 times, otherwise effects may be introduced which are not, in fact, realistic. Nevertheless, one can accelerate these tests up to a certain value of that order, and so get the answer in a matter of, say, six weeks as to what is likely to happen to the contents of the pack after a year's storage in practice.

I was glad to hear that our speaker from the aircraft industry mentioned the DEF.1234 specification. That is another specification to which we test packages for the Services' requirements abroad. DEF.1234 includes a test of cycling temperature and humidity conditions, and also a high temperature dry storage test; in other words, dry conditions with a temperature up to 140°F.

When testing packages to see whether they are, in fact, adequate, the effects of mechanical hazards should also be taken into account. This is done by duplicating the possible rough handling which the package may be subject to in practice by drop tests in the laboratory, dropping the package from a given height in various positions of fall, subjecting the pack to impacts, either blows on the side of the case or the type of shocks that the case may be subject to in practice due to shunting in railway wagons, for example, and to vibration. Vibration may come from two sources, either due to the transport itself travelling over rough roads or uneven railway lines, or high frequency vibration in the way of engine throb coming through, for example, the fuselage of an aircraft. A high frequency vibration test is also included in the DEF.1234 specification.

In our complete package testing work for items for export, we intersperse these tests for mechanical damage with those for the climatic hazards by, first of all, carrying out a series of drop vibration/impact tests on the case, and then subjecting it to a shower test and a period of tropical storage. If any waterproofing medium has been damaged in the preliminary mechanical tests, this will show up by the fact that a greater ingress of water into the pack than was expected will occur as a result of the shower and humidity tests. To complete the testing sequence, we carry out some more mechanical tests, drop tests and, maybe, stacking compression tests, on the case to determine whether the effect of moisture on the package has resulted in any weakening of the outer pack or lowering of its ability to support loads.

To sum up, I would stress that the testing of an export package for its resistance to climatic hazards should always be considered in relation to the mechanical tests to which the pack is subjected, and vice versa, to provide a complete testing sequence that approximates as nearly as possible to the conditions likely to be encountered in practice.

E. A. Bolton (Imperial Chemical Industries Ltd.):

On the question of moisture in cases, one might differentiate between moisture which is from not completely seasoned wood and moisture which is caused by weather conditions. In the first instance, there is probably present not only moisture, but also acid or other substances from the wood itself which may be more harmful than moisture.

Ordinarily, tar or bitumen from wrapping papers gives no trouble, but an instance of the effect of tar occurred during very hot weather conditions, the tar seeping from between the two layers of the wrapping paper and causing damage to the material which, in this instance, was tinned copper wire. This is not a common trouble, but it has occurred. Can the paper manufacturers say anything on that score?

Another point is the protection of the inspectors' and packers' hands so that they do not come in contact with the metal. An instance comes to mind in which copper wire had been coated with a tin-lead alloy. The customer found greyish-green deposits at intervals on the surface of the coils of wire. These appeared, on investigation, to be finger prints from the people who had carried out the inspection and wrapping which, in this case, was with crepe paper. The finger prints were not visible at the time of despatch, but under storage conditions, and possibly due to enclosure under wrapping paper, corrosion occurred. It was, fortunately, of a very minute nature; being more of a stain and not detrimental to the customer's process, the material being usable. Nevertheless, the wire did not look well and a rejection could have arisen.

In such cases where surface condition is so important, cotton gloves or something of a similar nature might be provided for the workers.

E. R. Barker (Carr and Co. (Paper) Ltd.):

I cannot stress too much how important it is that the chemical properties of packaging papers are watched extremely carefully. If you merely buy, say, a kraft union paper without watching these properties, and it is in direct contact with the metal, there can always be risks. Some people do watch these properties, even though they are not called for by the actual customer, and I wish more people in the industry would do the same.

A number of references have been made to the acidity of paper, but when you start dealing with non-ferrous metals you must watch the divergencies on the other end of the *p*H scale. One reference was made to corrugated paper. That is a very bad example, for you do get the use of sodium silicate, which can cause trouble.

Mouldable wrap, which was referred to, is a rather loose phrase which generally relates not to the cheese cloth or cotton scrim based product, but to a heavily waxed crepe kraft material. I agree that there may possibly be some risks of mould growth on that because it is not the normal practice to include a mould inhibitor in that particular product, but, given the demand, there is no reason why it cannot be done.

The material including the scrim is generally called scrimcel. Both of these materials are covered by D.E.F. specifications. That particular material consists of cotton scrim and cellophane, laminated and heavily surface coated with a self-adhesive wax, and there is a fungicide present in that particular product, and that is part and parcel of the Ministry specification. Incidentally, the CS numbers referred to a little earlier are rapidly going out of date and are being replaced by various DEF numbers, which will be familiar to all the principal paper converters to whom you might be likely to go for your supplies.

With regard to interleaving tissue, one speaker did mention the question of undigested pulp and gritty particles in cellulose wadding. It is equally true to watch that with tissues. You can get some very good quality tissues which are quite suitable but, on the other hand, if you are not careful, if you just go out and buy some tissue, you may find that while you are not getting chafing marks you are getting plenty of indentations, not merely in non-ferrous metals but also in much tougher metals like stainless steel.

On the question of barrier properties to moisture, kraft union is, of course, a good old stand-by. It is a very good material, but could be improved on. Waxed krafts have been mentioned, but their water vapour properties can be variable. At best they can be better than kraft union; at worst they can be four or five times more permeable than the kraft union. But there are also laminates made from kraft papers, with waxes and blends of wax with synthetic rubber, which will give you much better results than merely a bitumen lamination. The water vapour barrier properties of the materials tested under normal conditions will be better. They will also have better low temperature properties, and crack less easily under low temperature.

In this particular connection, the question of bitumen stain should be mentioned. This can come from several factors. Partly it can be because the bitumen used is of basically the wrong type. It is not hard enough to meet the tropical conditions. But this is a very rare fault. However, there is an instance where a firm has been using an additive in the bitumen to increase its adhesive properties, and possibly its flexibility. An additive has been made up in a solution in oil, which is then added to the bitumen and, of course, under tropical conditions the oil can tend to seep through.

Another factor is that if the metal parts which are packed have any oil on them, the oil itself can be drawn into the paper and into the bitumen, and bring the bitumen back on the metal, with the resultant need for cleaning afterwards, and it is a very messy business indeed. Waxes will tend to give rather better results in this way, but again the wax laminate being used for the purpose must be watched. Incidentally, these laminates generally include not merely two flat papers of some type laminated together, but they also include crepe krafts which are similarly laminated and are used in particular for spiral packing work. In that particular category of the crepe kraft union papers, the tendency is to use relatively poor quality waxes modified to make them viscous so that they do not penetrate the kraft in manufacture. As a consequence of rather low-grade waxes containing a lot of oil, there is a much greater risk that this oil will come through and mark metal surfaces which you are trying to keep clear of contamination. One very distinct instance of this is in

relation to fine copper wires which are subsequently going to be enamelled as insulation. Where there is oil on the copper, the lacquer does not stick. The nett result is that a breakdown occurs in electronic components, motors, etc. This can be got over with waxes, provided it is made clear to the supplier what can and what cannot be sustained.

A further barrier material which has not been referred to as yet and which is rather new in this country, is vinylidene chloride copolymer. One of the trade names is Saran, but there are also other coatings which can be put on paper of a similar chemical type. The actual formulations vary in the nature of the copolymers, as well as the extent, but some of them will give fantastic water vapour barrier properties. To quote an example, where kraft union papers with bitumen might vary from, say, 25-50 gm/m^2, under tropical test conditions on the P.A.T.R.A. tests, with some of these vinylidene chloride copolymer coatings readings of the order of 1-2 gm. can be obtained. Only foil laminates with good water vapour barrier adhesive, with which virtually nil readings are obtained, are better.

One other point about vinylidene chloride copolymer coating is that it is a gas barrier. It is not always true that a water vapour barrier is a good barrier to gases. The sulphur-bearing gases, in particular H_2S, tarnish copper.

There have been several references to the moisture content of wood, wedges and wood wool, etc., but the point has not been made that with a case and a liner and metal articles inside, with wooden battens or wood wool stuffed inside, you are defeating your own object, unless the water vapour barrier is completely on the inside of all those wood products which contain water.

Regarding inhibitors, someone referred to silica gel as an inhibitor; it is not really, it is something that absorbs the moisture of the atmosphere. It seems that vapour phase inhibitors are being confused with contact inhibitors. Sodium chromate is used as a contact inhibitor, and so is sodium benzoate, but opinions are that their value is limited.

It appears that sodium chromate does tend to cause dermatitis. Sodium benzoate is rather better. P.A.T.R.A. recommend it for packaging printers' zincos, and it is used in our own works. More people could profitably investigate sodium benzoate as a contact wrap, either as an impregnant for tissue paper for Interleaving or in kraft papers for immediate wrappings on the inside ply of kraft union paper. One widespread use of sodium benzoate is for the packaging of razor blades.

There is really only one vapour phase inhibitor which is widely known here and that is dicyclohexylamine nitrite. There is another one which has been publicized quite a lot, which is cyclohexylamine carbonate. The carbonate might be better for non-ferrous metals than the nitrite, but so far as the nitrite is concerned, extreme care is needed in using it for non-ferrous metals or non-ferrous metals mixed with ferrous metals. It is of some value in some instances, and of no value in others, and possibly harmful in other cases. As one speaker made it very clear, every single case must be taken on its merits. It is not the universal answer to packaging problems. With iron and steel—steel in particular—it is pretty cut and dried, but with non-ferrous metals its value in each particular case must be established. That does not mean to say that is the end of vapour phase inhibitors. There are other materials which are not known here, although people know of them being used abroad. For example, there is cyclohexylamine caprilate, for which claims have been made in connection with aluminium. We would be only too happy to work on some of these problems with people who are prepared to investigate them.

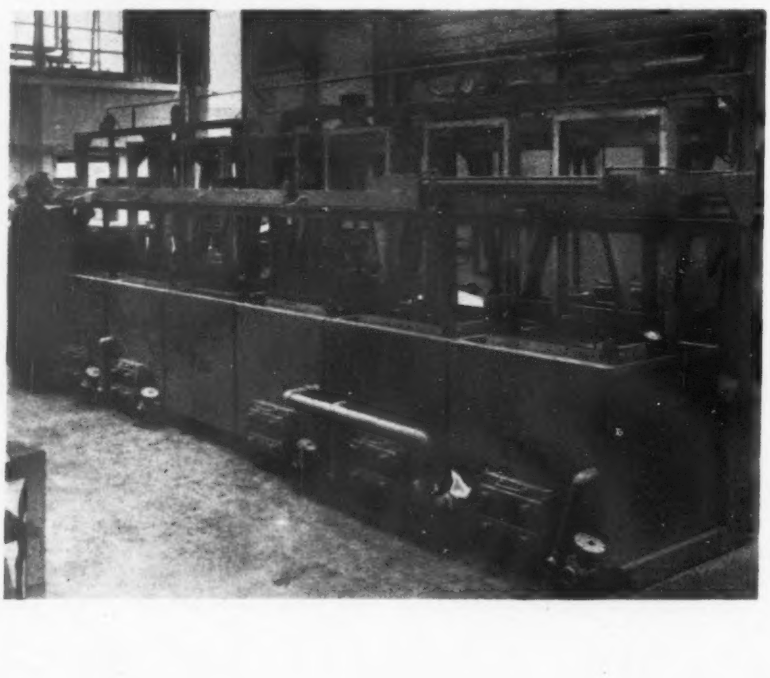
There are fatty acid amine derivatives which are put forward. Recently there was reference in the trade press to some form of amine for which patents have been taken out.

The last topic on these inhibitors is in connection with sulphur-bearing gases, which can only be dealt with by removing them from the atmosphere. For many years suggestions have been put forward, particularly in connection with silver. For example, everyone knows lead acetate will remove H_2S, but that is not the sort of thing to play around with in packaging. There are other materials which are safe. Over the years many patents have been taken out, but no one seems to have got down to commercializing them, largely because they have been thinking of silver, which has a much more limited field from the packaging manufacturers' point of view. They certainly have a use, particularly in connection with copper and copper-containing products where it is important to prevent any tarnish.

(To be continued)

Metal Pretreatment

FLEXIBLE in design, the Agi-Dip fully automatic multi-stage pretreatment plant that has just been introduced by the Electro-Chemical Engineering Co. Ltd., of Woking, Surrey, can be used for various types of cleaning and process treatments, including pickling and phosphating, on a wide variety of ferrous and non-ferrous metal components. In this type of plant, the parts to be treated are loaded into baskets, which are then automatically passed through agitated immersion stages, the number of these depending on the treatment required. Trichloroethylene vapour degreasing, spray rinsing and drying sections can be incorporated into the sequence if required.



The Agi-Dip automatic multi-stage pretreatment plant

Agitation is carried out by means of a reciprocating pneumatic arrangement that is adjustable for amplitude and frequency of stroke. Double acting air cylinders enable the work platforms to be driven down into the solutions at a faster rate than the freely falling components, thus effecting complete separation of tightly packed parts. The work is transported through the sequence by means of an index beam conveyor controlled by a timing mechanism. This mechanism can also operate automatic loading and unloading platforms to link the plant with a shop conveyor. Only one operator is normally required for the plant.

Industrial News *Home and Overseas*

Precious Metal Refining

It has been announced that **Johnson, Matthey and Company Ltd.** have taken an interest in the important Italian precious metal refining and manufacturing company Metalli Preziosi S.p.A. of Milan. This old-established company, which has a history of over one hundred years of association with precious metals, is by far the largest enterprise of its kind in Italy. It has its head office in Milan and its principal refineries and production centre in the new industrial zone of Paderno Dugnano, near Milan. Sales offices with local service facilities are maintained in Rome, Bologna, Florence, Genoa, Padua, Turin, Valenza, Vicenza and Verona. Extensions now in hand at the Paderno Dugnano works will presently complete a comprehensive modern precious metal, metallurgical and chemical production plant worthy of Italy's rapidly expanding industrial economy.

Johnson, Matthey have already been working in close collaboration with Metalli Preziosi for a number of years, and some ten years ago they entered into arrangements with this company with regard to their general representation in Italy. The closer association now announced is thus a logical development of previous understandings which have proved mutually advantageous. It provides for technical as well as commercial integration, and gives the Italian company access to the resources of the research organization of the Johnson Matthey group.

Galvanizing Conference

Provisional arrangements are now being made for the Sixth International Conference on **Hot Dip Galvanizing,** which is to be held in Cannes, France, in May, 1961. The conference will be organized by the European General Galvanizers Association, and detailed arrangements in France will be made by its member, the Association Technique Française de Galvanization.

Full particulars of the conference may be obtained in this country from the Zinc Development Association, secretary to the E.C.G.A., at 34 Berkeley Square, London, W.1. Papers for discussion are required on—work practice in general galvanizing; bath heating and control; galvanizing equipment; pretreatment of steel for galvanizing; metallurgy of galvanizing: influence of steel and bath composition; after-treatments of galvanized steel; the treatment of residues; corrosion of galvanized coatings; quality control in galvanizing; and sheet, wire and tube galvanizing.

Northern Representative

We learn from **Short and Mason Ltd.** that Mr. William K. Gregson has joined them as their Northern Area representative and will operate from 32 Park Road, Sale, Cheshire.

Hot Dip Galvanizing

In the belief that hot dip galvanizing is less appreciated than it should be, in spite of 150 years of history, the **Zinc Development Association** is showing two films in leading cities in this country. They are entitled "No Rust Here," a British production, and "Zinc Controls Corrosion," a film made in America. Last week these films were shown in the Grand Hotel, Manchester, the company including many industrialists from an area where atmospheric corrosion is very high.

Contracts from Russia

Two contracts have recently been negotiated with Russia by **Stewarts and Lloyds Ltd.** One is for £460,000 worth of boiler and steam tubes, and the other for £383,000 worth of oil well tubing for the Russian oil industry. Much of the tonnage involved (5,500 tons for the first contract and 4,100 tons for the second) will be produced at the company's works at Corby.

A New Subsidiary

Information from **R. J. Coley and Son (Northern) Ltd.** concerns the commencement of trading by its subsidiary, R. J. Coley and Son (Preston) Ltd. This subsidiary has taken over, from the first of this present month, the branch business previously conducted by R. J. Coley and Son (Northern) Ltd., at Stoneygate, Preston, Lancs., and on the same date also acquired the business of William Cook at 22-28 Gradwell Street, Preston, which it will continue to operate from that address.

Copper Ingots Wanted

Tenders are called for by the Ports, Railways and Transport Department, Lourenco Marques, Portuguese East Africa, for 36,000 kg. copper ingots. The closing date for receipt of tenders is May 29 next.

A copy of the tender announcement (in Portuguese) is with the Export Services Branch of the Board of Trade, Lacon House, Theobalds Road, London, W.C.1. A photo-copy can be purchased from the Branch on payment of 2s. 0d. (Ref. No. ESB/8928/59).

Contract Secured

An order for a continuous malleablizing plant for the production of ferritic and pearlitic blackheart malleable has just been secured by **Metalectric Furnaces Ltd.** from Gloucester Foundry Ltd. This furnace plant, which will have an output of half a ton of malleable castings an hour, is similar in design to a continuous unit already installed by Metalectric at the Dagenham works of the Ford Motor Company Ltd.

Provincial Offices

A new sub-office of **The English Electric Company Ltd.** was opened on the first of this month at 14 Albert Road, Middlesbrough. This office is in charge of Mr. A. R. Johnson, B.Sc., A.M.I.Mech.E., A.M.I.E.E.

A Heated Crucible Cover

To help light foundries casting aluminium and aluminium alloys, the **Electric Resistance Furnace Company Ltd.** have introduced a heated crucible cover fitted with solid rod heating elements operating at low voltage.

This lid is designed to maintain the temperature of liquid aluminium in the production of high quality metal, either by holding at temperature for several hours or by inducing into it, during the holding period, nitrogen or dried chloride gas. The lid can be made to fit existing holding pots of normal capacities or, alternatively, complete crucible assemblies can be supplied.

Engineering Research Laboratory

It is announced by the Council for Scientific and Industrial Research that in future the Mechanical Engineering Research Laboratory at East Kilbride, near Glasgow, will be known as the **National Engineering Laboratory.**

The Council has also decided to set up a steering committee to look after the programme of the Laboratory. The new committee will be under the chairmanship of Vice-Admiral Sir Frank Mason, K.C.B., M.I.Mech.E., M.I.Mar.E., and the members will be as follows:—Professor O. A. Saunders, M.A., D.Sc., M.I.Mech.E., F.R.S.; Mr. Norman Elce, M.Sc., M.I.Mech.E.; Dr. D. G. Sopwith, C.B.E., D.Sc., M.I.Mech.E.; and Dr. C. M. Cawley, C.B.E., D.Sc., F.R.I.C.

In order to assist the director as the Laboratory expands, and to improve and extend the links between the Laboratory and industry, two deputy directors have been appointed. They are Dr. S. P. Hutton, Ph.D., and Mr. F. D. Penny, B.Sc.

British Foundrymen

Scarborough is to be the venue of the 56th Annual Conference of the **Institute of British Foundrymen,** to be held from June 9 to 12 next. The conference office will be established at the Grand Hotel, Scarborough, and the annual general meeting will be held at the Spa Ballroom. The technical sessions will be held at the Library, in Vernon Road, while most of the social functions will be centred in the Grand and Royal Hotels, though the Friday evening supper dance will be held at the Olympia Ballroom. The annual banquet will be held in the evening of Wednesday, June 10, in the Grand Hotel.

Full details and handbook of the programme are available from the offices of the Institute at St. John Street Chambers, Deansgate, Manchester, 3.

Newcastle Offices

News from the Electric Motor Division of **Newman Industries Ltd.** is that the company has opened an additional area office at 59 Grey Street, Newcastle upon Tyne, under the management of Mr. R. Martindale. A stores, adjacent to the new office, will carry stocks of electric motors, and the company states that these facilities will provide a more efficient service in the north-east of England.

A New Pilot Dryer

Designed specifically to dry air and gases for transistor manufacture, atomic energy pilot plant, furnace atmosphere dewpoint control, stainless steel brazing and general process use, a new Birlec Pilot Dryer will be introduced by **Birlec Limited** at the International Transistor Exhibition, which is being held in London next month.

This new dryer weighs 75 lb., and is a readily portable unit for drying air and process gases on a pilot scale. It may be supplied with various desiccants, depending upon the intended application. For most common applications, the desiccant material of widest value is activated alumina; for other requirements, molecular sieve adsorbent, silica gel or aluminium silicate may be preferred.

Industrial Films

Two new films have recently been made available from the industrial division offices of **Mobil Oil Company Ltd.** The first of these films is entitled "Lubricants with Care," which has been made by Mobil Oil Française and deals with the manufacture, transportation, storage, application and reclamation of high grade lubricants.

The second film is entitled "Compressor Lubrication," and deals with the operating principles and lubrication of all types of compressors.

Nuclear Energy in Industry

A European Conference for Industrial Management on Industrial Prospects in Nuclear Energy is to take place in Stressa, Italy, from May 11 to 14 next. The Federation of British Industries has been responsible for organizing the British participation, which will consist of a number of speakers and 41 British delegates.

Soviet Tin Deposits

Exploitation of large tin deposits has commenced at Solnechni, near Komsomolsk-on-Amur, Pravda reports. A new mining town is being built near this deposit, the first in the Soviet Pacific area.

Welding Technology

Courses are being organized during the next two months by the **Institute of Welding** on various aspects of welding technology and allied subjects. The following are the provisional programmes:—Metal Spraying—May 4-6; Ultrasonic Inspection—May 25-28; Brazing Technology and Design—June 8-12; Welded Design and Construction in General and Mechanical Engineering—June 22-26.

Corrosion Exhibition

One of the most interesting exhibits at the Corrosion Exhibition, which is being held in London next week at the Royal Horticultural Society's New Hall, will be that provided by **Yorkshire Imperial Metals Limited.** Among the products being displayed on this stand will be the following:—"Yorkshire Imperial" solid drawn tubes in copper and a wide range of special copper-base alloys such as the well-known "Yorcalbro/Alumbro" (aluminium-brass), "Yorkshire 70/30 Cupro-Nickel/Kunifer 30," "Yorcoron/Kunifer 30A," "Yorcunife/Kunifer 5" (copper-nickel-iron), "Yorcunic/Kunifer 10," etc.

Bi-metal tubes and bi-metal plates for conferring resistance on both sides to dual corrosion conditions, especially in heat exchange equipment in the oil industry.

"Kuterlex" P.V.C. and polythene covered copper tubes for gas and water service pipelines installed in aggressive surroundings.

"Yorkshire Imperial" condenser and tube plates in a wide range of alloys, including "Alumbro" (aluminium-brass), manganese bronze, aluminium bronze (Alloy "D"), cupro-nickel 80/20 and 90/10, etc.

Copper and "Yorcasal" non-dezincifiable tube fittings.

A particularly interesting exhibit will show various forms of corrosion—corrosion-erosion, dezincification, season-cracking steam erosion, pitting, and many others, all of which can be avoided by the use of the correct "Yorkshire Imperial" alloy designed for the particular operating and other conditions involved. Another display will show "Yorkshire Imperial" plastics-covered copper tubing for instrumentation pipelines for use in corrosive atmospheres.

New Nickel Refinery

Recent news from Winnipeg is to the effect that the International Nickel Company of Canada will start immediately to build a nickel refinery worth 20 to 25 million dollars at Thompson, Manitoba, 400 miles north of Winnipeg. Announcing this, Mr. Duff Roblin, Premier of Manitoba, said the plant would provide employment for 300 men, in addition to those already expected to find jobs at the company's 175 million dollar development in the area.

The refinery, which will have a capacity of up to 75 million lb. of nickel per annum, is expected to start operations in 1960, reaching full production in 1961. It will employ a new process developed by company research scientists, and one by-product will be impure sulphur that could be refined for use in pulp making.

A Golf Meeting

Advance notice is given of the Spring Meeting of the **National Association of Non-Ferrous Metal Merchants' Golfing Society,** which is to be held on Thursday, May 14 next, at 9.30 a.m., at the Berkshire Golf Club, Ascot. Two rounds will be played: in the morning a round against Bogey for the President's prize, and in the afternoon a Greensome (playing the best drive of each couple) against Bogey.

A dinner will be held at the Mayfair Hotel, London, on the previous evening (Wednesday, May 13) at 6.45 p.m., and this will be followed by the annual general meeting of the society.

A Birlec Exhibit

A newly developed Birlec "hump-back" furnace has been introduced at the Engineering, Marine, Welding and Nuclear Exhibition now being held in London. Developed for the bright annealing and brazing of stainless steel components, the furnace, which is continuous in operation, is of the mesh belt conveyor type.

Rated at 20 kW, the furnace is provided with easily removable silicon carbide elements, which enable working temperatures up to 1,200°C. to be attained. The "hump-back" design, with sloping inlet and outlet tunnels, conserves the protective atmosphere gas used within the furnace.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange warehouses fell by 421 tons and were distributed as follows at the end of last week:—London 5,156 tons, Liverpool 2,954 tons, and Hull 1,095 tons.

The stocks of refined copper rose by 400 tons, distributed as follows:—London 1,972 tons, Liverpool 4,119 tons, Birmingham 850 tons, and Manchester 3,200 tons.

Welding News

It is reported from the Midlands that **Rubery Owen Ltd.** is to develop a new welding process recently acquired from America. A separate division of the company is to be formed, with the title of Rowen Arc, and will have its headquarters at Coventry.

This new process consists of a portable hand gun with a continuous electrode wire, and it is stated to be particularly valuable when applied to aluminium alloys. The equipment was originally developed by the Westinghouse Electric Corporation of U.S.A., and Rubery Owen, it is stated, will be the sole licensees in the U.K.

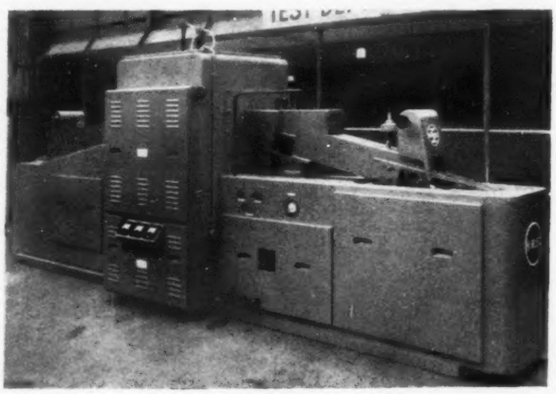
New Exhibit

One of the new exhibits at the Packaging Centre is that provided by the **Star Aluminium Company Limited,** who have added to their display a large coil of superfine aluminium, 40½ in. wide. Because of its size and special protective qualities, foil of this width is supplied to converters for printing, colouring and laminating to various materials for the packaging industries.

A Dexion Grid

Stated to be a revolutionary new multi-purpose grid which can be used to construct anything from industrial platforms and mobile stairs to car ramps and trolleys is an exhibit to be shown at the Dexion Building Exhibition at Stonebridge Park, Wembley, from May 26 to June 4. This new grid has been developed by the makers of Dexion slotted angle and is based on similar do-it-yourself principles.

Available in two sizes and a standard width, this grid can be quickly bolted together with fixing plates and standard Dexion nuts and bolts to suit almost any



The new Birlec "hump-back" furnace

purpose where a grid work or flooring is needed in any industry. It will be available in 9 in. widths, and in standard lengths of 4 ft. 6 in. and 6 ft. only. Non-standard lengths in multiples of $1\frac{1}{2}$ in. will be available in minimum quantities of 12.

Effluent Contract

A contract has been recently placed by Siemens Edison Swan with the **Kestner Evaporator and Engineering Company Ltd.** for a Kestner installation to neutralize the acid effluent from their plating shop. The new contract, to be installed at Siemens works at Woolwich, will consist of four Kestner patent continuous neutralizing units with the necessary ancillary plant. The whole will be in Kestner's special structural corrosion resistant plastics, Keebush, and will include their acid liquor pumps.

Indonesian Tin

A committee has been set up by the Indonesian Government to tackle problems in the tin industry. Dr. Ukar Bratakusumah, head of the committee, said their main task for the time being was to advise the Government in dealing with the ending of the International Tin Agreement on June 30, 1961. He said the committee would submit proposals to the Government to determine Indonesia's stand in the International Tin Council. They would have to study details and give suggestions to the Government on amendments to the agreement which would probably be made if the I.T.A. were extended, Dr. Bratakusumah added.

New Oil-Fired Tunnel Kiln

Fully alive to the need for constant improvement in manufacturing techniques and processes, **Thos. Marshall and Co. (Loxley) Ltd.,** Sheffield, manufacturers of fireclay refractories, planned a comprehensive programme of kiln development and modernization. The completion of the first stage was marked by the official opening of a new oil-fired tunnel kiln for burning hollow fireclay refractories. Dr. A. T. Green, C.B.E., D.Sc., F.R.I.C., director of research of the British Ceramic Research Association, pushed the first truck load in to the kiln. Almost 200 ft. long, with a capacity of 140 tons per week, the new kiln is claimed to be the largest in the U.K. to be used for this particular purpose.

The kiln is fired by four main special type burners supplied by Gibbons Bros. Ltd., Dudley, Worcs., the majority of the oil handling plant being by Reavell and Co. Ltd., Ipswich, and Duncan Low Ltd., Glasgow. Fuel oil consumption is estimated at 13 tons per week, equivalent to about 22 gallons of oil per ton of fired ware. Control of the finishing temperature is by means of separate automatic controls at each burner, the pyrometric and temperature control system being by Electroflo Meters Ltd. Recirculation is carried out in two separate zones in the preheating section of the kiln to ensure temperature uniformity, which is guaranteed to be within 10°C. throughout the car load. Additional burners in the preheat section can be brought into operation if desired. The main firing zone is semi-muffled so that, although the ware is protected against direct impingement of the flame, hot gases from the combustion chamber enter the kiln below the car deck and, if it is required to introduce more top heat, through damper-controlled ports above the muffles. The main construction of the kiln is typical of its type, and walls and crown are well insulated with materials supplied by Marshall's subsidiary company, Kingscliffe Insulating Products Ltd. Apart from the foundations, which were Marshall's responsibility entirely, the whole of the construction work on the kiln and dryer has been carried out by the contractors, Gibbons Brothers Ltd.

Industrial Law Course

Legal groundwork necessary to industrial managers and executives is to be covered in a three-day course on industrial and factory law to be given on May 26, 27 and 28 by Mr. Harry Samuels, O.B.E., M.A., barrister-at-law, under the auspices of the **Industrial Welfare Society.**

The course, which will be held at the Society's headquarters, Robert Hyde House, 48 Bryanston Square, London, W.1, is completely up to date with the latest changes in legislation, and, therefore, also serves as a refresher for executives who have not considered the subject for some time.

Turkish Copper Mines

During the early part of the second world war, Britain supplied much of the equipment for the Morgul Copper Mines in Eastern Turkey. For this project, **Head Wrightson Stockton Forge Limited** were responsible for providing classifying, grinding and drying equipment, in addition to a number of copper converters. Financed as part of the American I.C.A. dollar arrangements, large quantities of spares have been despatched to Turkey, and recently Head Wrightson have received orders for equipment amounting to 125,000 U.S. dollars from the Turkish Government Agency E.T.I. Bank.

Annual Meeting

On Wednesday, May 6 next, the annual general meeting of the Corrosion Group of the **Society of Chemical Industry** will be held at 14 Belgrave Square, London, S.W.1, at 6.30 p.m. After the conclusion of the business meeting, the chairman's address will be delivered by Dr. S. G. Clarke, with the title "Corrosion as a Design Problem."

Forthcoming Meetings

April 25—Institute of British Foundrymen. Lancashire Branch. Midland Hotel, Manchester. Annual General Meeting, followed by John Wilkinson prize-winning Paper and "Looking After the Apprentices." H. Haynes. 3 p.m.

April 27—Institute of British Foundrymen. Sheffield Branch. College of Commerce and Technology, Pond Street, Sheffield. Annual General Meeting, followed by "Question and Answer" Session. 7 p.m.

April 29—Institute of British Foundrymen. Southampton Branch. Technical College, St. Mary's Street, Southampton. Annual General Meeting, followed by "Application of Automatic Controls to Mould Production in Fully- and Semi-Mechanized Foundries." J. A. Hufton. 7.30 p.m.

April 30—Institute of Metals. Sheffield Section. Engineering Lecture Theatre, The University, St. George's Square, Sheffield, 1. Chairman's Address. Prof. R. W. K. Honeycombe, M.Sc., Ph.D. 7.30 p.m.

Men and Metals

Co-opted to the Council of the British Welding Research Association, **Mr. L. Rotherham,** M.Sc., F.Inst.P., F.I.M. is a member for research of the Central Electricity Generating Board. Mr. Rotherham, who was chief metallurgist and director of research and development, U.K.A.E.A. (Industrial Group) from 1950 to 1958, is also a member of the Scientific Advisory Council of the Ministry of Power, and of the General Board of the National Physical Laboratory.

At a meeting of the Committee of the Engineering Centre, Birmingham, **Mr. Victor Brenner** was re-elected President for the fourth year, and **Mr. C. J. Grazebrook** and **Mr. A. G. Banks** were re-elected vice-president and treasurer respectively. Normally, the President serves for a term of three years, but the Centre felt that Mr. Brenner should be asked to serve for another year in view of the active developments being undertaken at the Centre with which he has been so much associated.

It has been announced by the English Steel Corporation that **Mr. A. H. Hird,** A.C.G.I., B.Sc., M.I.Mech.E., has been appointed to the board of the Corporation. Mr. Hird is a director of Vickers Limited and a number of its subsidiary companies. He was attached to the staff of the Corporation during the early years of the second world war.

Director of the Zinc Development Association, **Mr. R. Lewis Stubbs** has left on a three months' tour of Australia, Canada and India.

The first awards of the Diploma in Technology in Metallurgy in this country are to be conferred upon six students at the College of Technology, Birmingham, who have satisfied the examiners in the final examinations in metallurgy. The National Council for Technological Awards will consider the conferment of the Diploma on these students only after satisfactory completion of their six months' industrial training. The students are:—Honours, Class 1—**Brian Granville Harrison** (Imperial Chemical Industries Ltd.); Honours, Class 2, Division 1—**Robert Thomas Derricott** (Accles and Pollock Ltd.) and **David Arthur Hewston** (Imperial Chemical Industries Ltd.); Honours, Class 2, Division 2—**Kenneth Arthur Harrison** (Joseph Lucas Ltd.) and **Terence John Pitt** (Guest, Keen and Nettlefold Ltd.); and Pass—**Peter Joseph Higgins** (Joseph Lucas Ltd.).

News from Head, Wrightson and Company Limited is to the effect that the **Rt. Hon. The Earl of Halsbury,** F.R.I.C., F.Inst.P., has joined the board of Head, Wrightson Processes Limited.

Metal Market News

THE collapse in the copper price last week, which is discussed below, could not by any means be ascribed to the March statistics published by the Copper Institute, for the figures are reasonably good. In short tons of 2,000 lb., details are as follows: inside the United States production of crude copper amounted to 117,235 tons, against 99,857 tons in February, while in refined copper the corresponding figures were 140,928 tons and 142,235 tons respectively. Deliveries of refined copper were 124,200 tons, compared with 120,134 tons in February. Stocks of refined copper, at 82,952 tons, were down by 2,571 tons. Outside the United States, output of crude was 168,497 tons, fully 11,000 tons up, while production of refined copper amounted to 144,497 tons, against 121,783 tons in February. Deliveries, too, advanced, from 123,607 tons to 146,605 tons, while stocks rose by 17,452 tons to 236,232 tons. The nett increase in stocks was, therefore, nearly 15,800 tons. The British Bureau of Non-Ferrous Metal Statistics give the U.K. February usage of copper, refined and secondary, at 48,293 tons, or 4,700 tons lower than January, and about 12,000 down on November. This is a serious drop even allowing for the fact that the November total was exceptionally favourable, and it may well foreshadow a reduced rate of usage during the present year. The figures given above show that the rate of world production is rising, and there is every indication that later on this year there is going to be plenty of copper, almost certainly too much. Only one thing can stop a glut developing and that is a prolonged strike, the chances of which seem to be getting less.

The standard copper quotation last week suffered a spectacular fall and by Thursday, when the bottom was reached, the loss from the previous Friday amounted to £14. The main cause of the decline in London was the collapse of the big bull account on Comex which, at varying levels, had been in existence for fully 12 months. Loss of confidence by speculators in the States was enhanced by an announcement that the American Government intended to release more than 100,000 short tons of copper from the stockpile. The authenticity of this was called into question, but this did not prevent further heavy liquidation in futures. However, on Friday the market cheered up on the assumption that the release would not take place, and subsequently it became known that the Government's idea was to market copper in modest quantities from time to time so as not to upset the balance of supply and demand. Trading in Whittington Avenue was very active throughout the week and the turnover amounted to about 18,600 tons without Kerb dealing, which probably accounted for another 10,000 tons. Business on this scale has not been seen for many a long day.

The week started off with an increase of 100 tons in L.M.E. copper stocks to 9,741 tons, but on Monday also came news that the custom smelters had reduced to 32 cents. In midweek, the quotation on Comex dropped by 100 to 125 points, with very heavy trading, which, indeed, persisted all through the week. A setback was seen on Friday afternoon's session and the close was £232 15s. 0d. cash and three months, which showed a loss of £11 5s. 0d. in both positions. Confidence has been badly shaken, and at the moment it does not appear as though much recovery is in sight. So far as price fluctuations were concerned, copper stole all the thunder last week for there was not much change in the other metals. Tin stocks declined again by 553 tons to 9,626 tons, and on the week cash gained £3 10s. 0d. to close at £784, while three months was £1 better at £785. April lead, at £68 10s. 0d., was 5s. up, while July gained 2s. 6d. to £69 17s. 6d. Both positions in zinc put on 7s. 6d. at £72 5s. 0d. and £71 17s. 6d. for April and July.

New York

Custom smelters reported satisfactory business at their price of 32 cents a pound. Large producers say business is satisfactory at 31.50 cents per lb. Meanwhile, the buying price of scrap copper was raised by leading custom smelters to 25·75 cents per lb., with business at this level small. On the Commodity Exchange, copper futures were higher, with dealings fairly active. The strength in scrap and on the Commodity Exchange, together with reported better business by custom smelters, reflects the lessening concern over possible release of copper from the Government stockpile. Most copper circles are of the opinion that the Government will not release the copper because of the very unfavourable reaction to it by leading law-makers and by the trade in general. A continued improvement in the volume of lead business is reported by trade sources, while zinc was said to be slow. Some quarters predicted there was a good possibility of the lead price being raised early next week.

The Senate has approved a resolution opposing Government disposal of stockpiled copper. The resolution, approved by a voice vote only two days after its introduction, formally states the Senate's opinion that release of copper stocks would raise "incalculable danger to the national security and to the economic well being of the nation." Western Senators reported there has been no change in the desire by the Office of Civil and Defense Mobilization to cut down on its copper stockpile. The O.C.D.M. is still trying to find a way to gradually sell copper in such a way that it would not injure the world market, these sources said.

Exploration of placer tin deposits on the western tip of Alaska's Seward Peninsula, near the Arctic Circle, is described in a Bureau of Mines publication released by the Department of the Interior. Although now idle, the area produced more than 500 tons of tin between 1935 and 1941. Bureau of Mines sampling early in World War II had indicated that further investigation of the deposits was warranted.

Birmingham

Further indications of slight expansion in the metal-using industries in the Midlands have been forthcoming. The building industry is more active, bringing a bigger demand for ironfoundry and brassfoundry used in the trade. More work has been placed with local rolling stock firms by the British Transport Commission in connection with their modernization programme. Makers of electrical equipment get a good share of this work. Machine tool firms are working below capacity, and order books are not large enough yet to predict a return to more active conditions, but manufacturers hope that business will be stimulated by Budget reliefs.

Industrialists take the view that expansion in the iron and steel trade will be slow, but already there is some increase in output, which, it is hoped, will be maintained and possibly improved during the current quarter. The motor trade continues to take substantial quantities of sheet steel and iron castings. Demand for heavy engineering castings is satisfactory, and there is some improvement in production of light castings. Re-rolling firms, however, are still short of orders and short-time working is in force in a number of works.

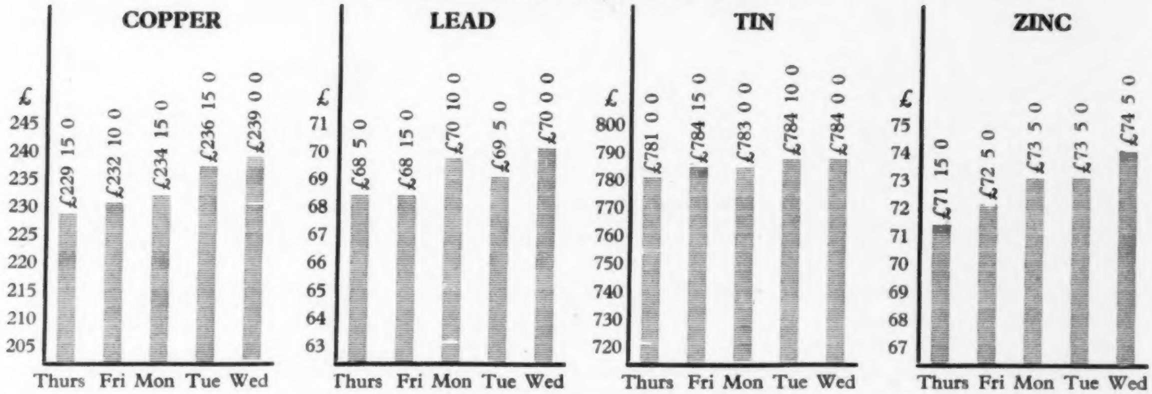
Zurich

There has been a further regression in business on the Swiss non-ferrous metal market, which was already very quiet, and turnovers are considerably below what they were a month ago, according to trade quarters. An improvement in demand from the building industry has not been enough to offset the drop in offtake from other sectors which have been running down their stocks of metal. Trade circles say that the main reason for the generally reserved attitude of the consumers is the downward trend on international market. Furthermore, in many branches of industry the inflow of new orders is falling off.

Non-Ferrous Metal Prices

London Metal Exchange

Thursday 16 April to Wednesday 22 April 1959



Primary Metals

All prices quoted are those available at 2 p.m. 22/4/59

		£	s.	d.
Aluminium Ingots	ton	180	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%	„	190	0	0
Antimony Oxide	„	180	0	0
Antimony Sulphide Lump	„	190	0	0
Antimony Sulphide Black Powder	„	205	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		9	0
Calcium	„	2	0	0
Cerium 99%	„	16	0	0
Chromium	„		6	11
Cobalt	„		14	0
Columbite per unit			—	
Copper H.C. Electro	ton	239	0	0
Fire Refined 99·70%	„	238	0	0
Fire Refined 99·50%	„	237	0	0
Copper Sulphate	ton	79	0	0
Germanium	grm.		—	
Gold	oz.	12	9	1½
Indium	„		10	0
Iridium	„	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	70	0	0
Magnesium Ingots	lb.		2	3
Notched Bar	„		2	9½
Powder Grade 4	„		6	1
Alloy Ingot, A8 or AZ91	„		2	4
Manganese Metal	ton	245	0	0
Mercury	flask	79	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	
Palladium	oz.	7	5	0
Platinum	„	28	10	0
Rhodium	„	40	0	0
Ruthenium	„	18	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	7⅛
Tellurium	lb.		15	0
Tin	ton	784	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	73	19	4½
Dust 95/97%	„	109	0	0
Dust 98/99%	„	115	0	0
Granulated 99+%	„	98	19	4½
Granulated 99·99+%	„	112	2	6

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏£/ton		Canada c/lb ≏£/ton		France fr/kg ≏£/ton		Italy lire/kg ≏£/ton		Switzerland fr/kg ≏£/ton		United States c/lb ≏£/ton	
Aluminium			22.50	185 17 6	224	163 0	375	221 5	2.50	212 10	26.80	214 10
Antimony 99.0					220	165 0	445	262 10			29.00	232 0
Cadmium					1,350	1,012 10					130.00	1,040 0
Copper												
Crude												
Wire bars 99.9							475	280 5 0				
Electrolytic	33.00	242 17 6	30.50	252 0	332	249 0			2.90	246 12 6	31.50	252 0
Lead			10.25	84 12 6	102	76 12 6	164	96 15	.85	74 0	11.00	88 0
Magnesium												
Nickel			70.00	578 5	900	675 0	1,200	708 0	7.50	637 10	74.00	592 0
Tin	111.00	817 2 6			1,125	843 17 6	1,500	885 0	9.60	816 0	102.25	818 0
Zinc												
Prime western			10.75	88 15 0							11.00	88 0
Highgrade 99.95			11.35	93 15 0								
Highgrade 99.99			11.75	97 0 0								
Thermic					107.00	80 5						
Electrolytic					115.00	86 5	165	97 7 6	.95	80 17 6	12.25	98 0

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 22/4/59

Aluminium Alloy (Virgin)		£	s.	d.
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	,,	202	0	0
B.S. 1490 L.M.7	,,	216	0	0
B.S. 1490 L.M.8	,,	203	0	0
B.S. 1490 L.M.9	,,	203	0	0
B.S. 1490 L.M.10	,,	221	0	0
B.S. 1490 L.M.11	,,	215	0	0
B.S. 1490 L.M.12	,,	223	0	0
B.S. 1490 L.M.13	,,	216	0	0
B.S. 1490 L.M.14	,,	224	0	0
B.S. 1490 L.M.15	,,	210	0	0
B.S. 1490 L.M.16	,,	206	0	0
B.S. 1490 L.M.18	,,	203	0	0
B.S. 1490 L.M.22	,,	210	0	0
†Aluminium Alloys (Secondary)				
B.S. 1490 L.M.1	ton	—		
B.S. 1490 L.M.2	,,	—		
B.S. 1490 L.M.4	,,	—		
B.S. 1490 L.M.6	,,	—		
***Aluminium Bronze**				
BSS 1400 AB.1	ton	229	0	0
BSS 1400 AB.2	,,	—		

*Brass		£	s.	d.
BSS 1400-B3 65/35	ton	155	0	0
BSS 249	,,	—		
BSS 1400-B6 85/15	,,	198	0	0
***Gunmetal**				
R.C.H. 3/4% ton	,,	—		
(85/5/5/5)	,,	193	0	0
(86/7/5/2)	,,	203	0	0
(88/10/2/1)	,,	240	0	0
(88/10/2/½)	,,	256	0	0
***Manganese Bronze**				
BSS 1400 HTB1	,,	190	0	0
BSS 1400 HTB2	,,	200	0	0
BSS 1400 HTB3	,,	—		
Nickel Silver				
Casting Quality 12%	,,	220	0	0
,, ,, 16%	,,	230	0	0
,, ,, 18%	,,	240	0	0
***Phosphor Bronze**				
B.S. 1400 P.B.1.(A.I.D. released)	,,	284	0	0
B.S. 1400 L.P.B.1	,,	212	0	0

**Average prices for the last week-end.*

Phosphor Copper		£	s.	d.
10%	ton	255	0	0
15%	,,	257	10	0
Phosphor Tin				
5%	,,	—		
Silicon Bronze				
BSS 1400-SB1	,,	250	0	0
Solder, soft, BSS 219				
Grade C Tinmans	,,	364	5	0
Grade D Plumbers	,,	293	0	0
Grade M	,,	400	0	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.	—		
Type 9 ,,	,,	—		
Zinc Alloys				
Mazak III	ton	105	7	6
Mazak V	,,	109	7	6
Kayem	,,	115	7	6
Kayem II	,,	121	7	6
Sodium-Zinc	lb.		2	6

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium				
Sheet 10 S.W.G.	lb.		2	8½
Sheet 18 S.W.G.	,,		2	10½
Sheet 24 S.W.G.	,,		3	1½
Strip 10 S.W.G.	,,		2	8½
Strip 18 S.W.G.	,,		2	9½
Strip 24 S.W.G.	,,		2	11
Circles 22 S.W.G.	,,		3	2½
Circles 18 S.W.G.	,,		3	1½
Circles 12 S.W.G.	,,		3	0½
Plate as rolled	,,		2	8
Sections	,,		3	2
Wire 10 S.W.G.	,,		2	11½
Tubes 1 in. o.d. 16 S.W.G.	,,		4	1
Aluminium Alloys				
BS1470. HS10W.				
Sheet 10 S.W.G.	,,		3	1
Sheet 18 S.W.G.	,,		3	3½
Sheet 24 S.W.G.	,,		3	11
Strip 10 S.W.G.	,,		3	1
Strip 18 S.W.G.	,,		3	2½
Strip 24 S.W.G.	,,		3	10½
BS1477. HP30M.				
Plate as rolled	,,		2	11
BS1470. HC15WP.				
Sheet 10 S.W.G.	,,		3	9½
Sheet 18 S.W.G.	,,		4	2
Sheet 24 S.W.G.	,,		5	0½
Strip 10 S.W.G.	,,		3	10½
Strip 18 S.W.G.	,,		4	2
Strip 24 S.W.G.	,,		4	9½
BS1477. HPC15WP.				
Plate heat treated	,,		3	6½
BS1475. HG10W.				
Wire 10 S.W.G.	,,		3	10½
BS1471. HT10WP.				
Tubes 1 in. o.d. 16 S.W.G.	,,		5	0½
BS1476. HE10WP.				
Sections	,,		3	1½
Brass				
Tubes	,,		1	10
Brazed Tubes	,,		—	
Drawn Strip Sections	,,		—	
Sheet	ton		—	
Strip	,,	251	15	0
Extruded Bar	lb.		2	0¼
Extruded Bar (Pure Metal Basis)	,,		—	

Brass				
Condenser Plate (Yellow Metal)	ton	187	0	0
Condenser Plate (Naval Brass)	,,	199	0	0
Wire	lb.		2	7⅞
Beryllium Copper				
Strip	,,	1	4	11
Rod	,,	1	1	6
Wire	,,	1	4	9
Copper				
Tubes	lb.		2	3⅛
Sheet	ton	264	10	0
Strip	,,	264	10	0
Plain Plates	,,		—	
Locomotive Rods	,,		—	
H.C. Wire	,,	285	15	0
Cupro Nickel				
Tubes 70/30	lb.		3	6¾

Lead				
Pipes (London)	ton	108	5	0
Sheet (London)	,,	106	0	0
Tellurium Lead	,,	£6 extra		
Nickel Silver				
Sheet and Strip 7%	lb.		3	8½
Wire 10%	,,		4	3¼
Phosphor Bronze				
Wire	,,		4	1
Titanium (1,000 lb. lots)				
Billet over 4″ dia.-18″ dia.	lb.	63/-	64/-	
Rod 4″ dia.-·250″ dia.	,,	75/-	112/-	
Wire under ·250″ dia.-·036″ dia.	,,	146/-	222/-	
Sheet 8′ × 2′ × ·250″-·010″		88/-	157/-	
Strip ·048″-·003″	,,	100/-	350/-	
Tube	,,		300/-	
Extrusions	,,		120/-	
Zinc				
Sheet	ton	108	15	0
Strip	,,	nom.		

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 21/4/59.

Aluminium	£
New Cuttings	146
Old Rolled	126
Segregated Turnings	97
Brass	
Cuttings	160
Rod Ends	141
Heavy Yellow	124
Light	119
Rolled	150
Collected Scrap	122
Turnings	134
Copper	
Wire	211
Firebox, cut up	206
Heavy	203
Light	198
Cuttings	211
Turnings	192
Braziery	172

Gunmetal	£
Gear Wheels	183
Admiralty	183
Commercial	165
Turnings	160
Lead	
Scrap	59
Nickel	
Cuttings	—
Anodes	550
Phosphor Bronze	
Scrap	165
Turnings	160
Zinc	
Remelted	62
Cuttings	53
Old Zinc	37

Metal Statistics

Detailed figures of the consumption and output of non-ferrous metals for the month of Feb., 1959, have been issued by the British Bureau of Non-Ferrous Metal Statistics, as follows in long tons:—

COPPER	Gross Weight	Copper Content
Wire	19,019	18,642
Rods, bars and sections	11,665	7,692
Sheet, strips and plate	12,525	9,966
Tubes	6,259	5,796
Castings and miscellaneous	6,561	—
Sulphate	3,273	—
	59,302	48,293

Of which:	
Consumption of Virgin Copper	35,775
Consumption of Copper and Alloy Scrap (Copper Content)	12,518

LEAD	
Cables	7,236
Batteries	2,411
Battery Oxides	2,198
Tetra Ethyl Lead	1,624
Other Oxides and Compounds	2,281
White Lead	559
Shot	307
Sheet and Pipe	4,784
Foil and Collapsible Tubes	261
Other Rolled and Extruded	505
Solder	1,116
Alloys	1,589
Miscellaneous Uses	1,097
Total	25,968

TIN	
Tinplate	713
Tinning:	
Copper Wire	49
Steel Wire	9
All other	61
Solder	194
Alloys	452
Foil and Collapsible Tubes, etc.	44
Tin Compounds, Salts, and Miscellaneous Uses	92
Total Consumption	1,614

ZINC	
Galvanizing	7,600
Brass	7,992
Rolled Zinc	2,131
Zinc Oxide	2,249
Zinc Die-casting alloy	4,018
Zinc Dust	847
Miscellaneous Uses	839
Total, All Trades	25,676
Of which:	
High purity 99·99 per cent	4,335
Electrolytic and high grade 99·95 per cent	4,946
Prime Western, G.O.B. and debased	9,738
Remelted	431
Scrap Brass and other Cu alloys	3,414
Scrap Zinc, alloys and residues	2,612

ANTIMONY	
Batteries	94
Other Antimonial Lead	38
Bearings	29
Oxides—for White Pigments	123
Oxides—other	77
Miscellaneous Uses	18
Sulphides	4
Total Consumption	383

Antimony in Scrap	
For Antimonial Lead	347
For Other Uses	16
Total Consumption	363

CADMIUM	
Plating Anodes	39·60
Plating Salts	10·75
Alloys: Cadmium Copper	6·25
Alloys: Other	3·25
Batteries: Alkaline	6·80
Batteries: Dry	0·50
Solder	7·25
Colours	22·20
Miscellaneous Uses	1·80
Total Consumption	96·40

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£205.17.6)	235
Heavy copper	(£201.10.0)	230
Light copper	(£175.5.0)	200
Heavy brass	(£118.5.0)	135
Light brass	(£92.0.0)	105
Soft lead scrap	(£57.0.0)	65
Zinc scrap	(£36.15.0)	42
Used aluminium unsorted	(£83.5.0)	95

France (francs per kilo):		
Electrolytic copper scrap	(£191.5.0)	255
Heavy copper	(£191.5.0)	255
No. 1 copper wire	(£180.0.0)	240
Light brass	(£112.12.6)	150
Zinc castings	(£48.15.0)	65
Lead	(£64.12.6)	86
Aluminium	(£120.0.0)	160

Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£197.12.6)	335
Aluminium copper alloy	(£126.17.6)	215
Lead, soft, first quality	(£75.12.6)	128
Lead, battery plates	(£41.17.6)	71
Copper, first grade	(£221.5.0)	375
Copper, second grade	(£209.10.0)	355
Bronze, first quality machinery	(£206.12.0)	350
Bronze, commercial gunmetal	(£183.0.0)	300
Brass, heavy	(£144.10.0)	245
Brass, light	(£129.17.6)	220
Brass, bar turnings	(£132.15.0)	225
New zinc sheet clippings	(£56.0.0)	95
Old zinc	(£41.7.6)	70

Financial News

F. W. Berk and Co.

Subject to audit, group net profit £189,557 (£149,371) after tax £203,339 (£209,513) and crediting unrequired tax £13,000 (nil). To replacement reserve £30,000 (£20,000), general reserve £50,000 (£20,000). Group forward £341,469 (£320,104). Final dividend 7½ per cent, making 10 per cent for the year.

Edwards High Vacuum

Group trading profits rose from £179,636 to £224,035 and the net profit from £76,458 to £107,268 after tax of £116,767 (£103,178). After minority interests and an unrequired provision of £7,325 (£8,322), the parent's net balance is £113,190, compared with £83,775. General reserve receives £60,000 (£40,000), leaving £39,281 (£35,122) to go forward. Final dividend at 12 per cent, making 16 per cent for the year.

General Refractories Ltd.

At the Extraordinary General Meeting of the company, held last week, the resolution to increase the authorized share capital of the company from £1½ million to £2 million, by the creation of a further one million Ordinary shares of 10s., each ranking *pari passu* with the existing Ordinary shares, was approved.

An Acquisition

It has been announced that the Sheffield Wire Rope Co. Ltd., of Darnall, Sheffield, has recently been acquired by the Firth Cleveland group of companies. The chairman of the company will in future be Mr. C. W. Hayward (chairman of Firth Cleveland Ltd.), and the other directors will be Mr. E. S. Mead, Mr. R. S. H. Shepard, Mr. G. F. Chambers, Mr. S. K. Wheatley, Mr. H. V. W. Buckler and Mr. B. Allen.

Trade Publications

Rectangular Aluminium Busbar. — Northern Aluminium Company Ltd., Banbury, Oxon.

This is an eight-page brochure containing data on the mechanical and electrical properties of electrical-purity aluminium (Noral C1SM) and the new conductor alloy (Noral D50SWP) that has been specially developed for electrical applications. Current ratings for a range of rectangular busbar sections are given, and recommendations on jointing methods are made. A new joint compound is described, and there is a short section on the bending of busbar, and the correct types of bolts, nuts and washers are specified.

Copper Alloy Strip.—Imperial Chemical Industries Limited, Metals Division, P.O. Box 216, Birmingham, 6.

A leaflet describes the "Kuniform" range of fine grain copper alloy strip, developed expressly to facilitate polishing and reduce labour costs in pressings in brass or gilding metals.

Suspension Magnets. — Rapid Magnetic Machines Ltd., Lombard Street, Birmingham, 12.

A recent publication (No. 130) covers the "Rapid" deep field suspension magnets for extracting tramp iron.

THE STOCK EXCHANGE

Industrials Continued Active. Despite Profit-taking Undertone Remained Firm

ISSUED CAPITAL ●	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 21 APRIL	+RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV YEAR	DIV. YIELD	1959 HIGH	1959 LOW	1958 HIGH	1958 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	26/6	+6d.	9	10	6 15 9	27/-	23/3	24/9	17/6
400,000	2/-	Anti-Attrition Metal	1/6		4	8½	5 6 9	—	—	1/9	1/3
41,305,038	Stk. (£1)	Associated Electrical Industries ...	60/6	+3d.	15	15	4 19 3	60/6	54/-	58/9	46/6
1,609,032	1	Birfield	48/-	—6d.	15	15	6 5 0	59/-	47/6	62/4½	46/3
3,196,667	1	Birmid Industries	75/-		17½	17½	4 13 3	76/10½	72/-	77/6	55/3
5,630,344	Stk. (£1)	Birmingham Small Arms	41/3	+1/6	11	10	5 6 9	41/3	36/1½	39/-	23/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	16/3		5	5	6 3 0	16/3	15/-	16/1½	14/7½
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/9		6	6	6 15 3	18/1½	17/9	17/4½	16/6
500,000	1	Bolton (Thos.) & Sons	27/6		10	12½	7 5 6	28/3	27/6	28/9	24/-
300,000	1	Ditto Pref. 5%	15/6		5	5	6 9 0	15/6	15/-	16/-	15/-
160,000	1	Booth (James) & Co. Cum. Pref. 7%	20/6		7	7	6 16 6	—	—	20/4½	19/-
1,500,000	Stk. (£1)	British Aluminium Co. Pref 6% ...	19/6		6	6	6 3 0	19/7½	18/9	20/-	18/4½
15,030,000	Stk. (£1)	British Insulated Callender's Cables	52/6	—6d.	12½	12½	4 15 3	53/-	47/6	52/6	38/9
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	55/-	+6d.	10	10	3 12 9	56/-	49/3	52/-	28/3
600,000	Stk. (5/-)	Canning (W.) & Co.	30/9	+2/3	25 + *2½C	25	4 1 3	30/9	24/9	25/3	19/3
60,484	1/-	Carr (Chas.)	1/10½		12½	25	6 13 3	2/3	1/3	2/3	1/4½
150,000	2/-	Case (Alfred) & Co. Ltd.	5/-		25	25	10 0 0	5/3	4/7½	5/3	4/-
555,000	1	Clifford (Chas.) Ltd.	23/-		10	10	8 14 0	23/-	22/6	22/-	16/-
45,000	1	Ditto Cum. Pref. 6%	16/-	+9d.	6	6	7 10 0	16/-	15/3	16/-	15/-
250,000	2/-	Coley Metals	3/4½		20	25	11 17 0	3/4½	2/10½	4/6	2/6
8,730,596	1	Cons. Zinc Corp.†	60/6	+6d.	18¾	22½	6 4 0	67/6	60/-	65/3	41/-
1,509,529	1	Davy & United	97/-	+1/-	20	15	4 2 6	97/-	86/-	87/-	45/9
2,915,000	5/-	Delta Metal	33/7½xd	+1/-	31	30	4 12 3	33/7½	24/1½	25/-	17/7½
4,600,000	Stk. (£1)	Enfield Rolling Mills Ltd.	45/-	—2/-	15	12½	6 13 3	48/-	36/7½	38/-	22/9
750,000	1	Evered & Co.	31/6		10 §	15 Z	6 7 0	31/6	30/-	30/-	26/
18,000,000	Stk. (£1)	General Electric Co.	32/-	—2/-	10P	12½		40/3	30/9	40/6	29/6
1,500,000	Stk. (10/-)	General Refractories Ltd.	33/9	—6d.	20	20	5 18 6	40/-	33/9	39/3	27/3
401,240	1	Gibbons (Dudley) Ltd.	64/-		15	15	4 13 6	66/6	64/-	67/6	61/-
750,000	5/-	Glacier Metal Co. Ltd.	7/-	+3d.	11½	11½	8 4 3	7/1½	6/7½	8/3	5/-
1,750,000	5/-	Glynwed Tubes	18/10½	+1/4½	20	20	5 6 0	19/3	16/4½	18/1½	12/10½
5,421,049	10/-	Goodlass Wall & Lead Industries ...	33/9	+1/-	13‖	18Z	3 17 0	33/9	28/7½	30/9	17/3
342,195	1	Greenwood & Batley	81/9	+9d.	20	17½	4 18 0	83/9	75/-	57/9	45/-
396,000	5/-	Harrison (B'ham) Ord.	18/-	—1½d.	*17½	*15	4 17 3	18/7½	14/11½	15/9	11/6
150,000	1	Ditto Cum. Pref. 7%	19/6		7	7	7 3 6	—	—	19/9	18/4½
1,075,167	5/-	Heenan Group	8/1½	—4½d.	10	10‡	6 3 0	8/6	7/6	9/7½	6/9
236,959,260	Stk. (£1)	Imperial Chemical Industries ...	33/9	—1/1½	12Z	10	4 14 9	38/3	33/9	38/-	24/3
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	17/-		5	5	5 17 9	17/-	16/-	17/1½	16/-
14,584,025	**	International Nickel	162¾	+½	$2.60	$3.75	2 16 6	171	153	169	132¾
860,000	5/-	Jenks (E. P.), Ltd.	9/9	—3d.	14	27½ϕ	7 3 6	10/-	8/9	10/-	6/7½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	16/3		5	5	6 3 0	16/3	15/4½	16/9	15/-
3,987,435	1	Ditto Ord.	47/-		10	10	4 5 0	52/6	44/3	47/-	36/6
600,000	10/-	Keith, Blackman	28/6	+1/-	17½E	15	6 2 9	28/6	25/-	28/9	15/-
320,000	4/-	London Aluminium	5/7½	—4½d.	10	10	7 2 3	6/4½	5/3	6/-	3/-
765,012	1	McKechnie Brothers Ord.	42/6		15	15	7 1 3	45/-	42/6	45/-	32/-
1,530,024	1	Ditto A Ord.	40/-		15	15	7 10 0	43/6	40/-	45/-	30/-
1,109,269	5/-	Manganese Bronze & Brass	15/6		20	27½‡	6 9 0	15/6	13/9	14/1½	8/9
50,628	6/-	Ditto (7½% N.C. Pref.)	6/-		7½	7½	7 10 0	—	—	6/3	5/6
13,098,855	Stk. (£1)	Metal Box	76/3	—1/3	11	11	2 17 9	78/9	66/6	73/3	40/6
415,760	Stk. (2/-)	Metal Traders	9/9	+3d.	50	50	10 5 3	9/9	8/4½	9/-	6/3
160,000	1	Mint (The) Birmingham	24/-	+9d.	10	10	8 6 9	24/-	22/-	22/9	19/-
80,000	5	Ditto Pref. 6%	72/6		6	6	8 5 6	75/6	69/-	83/6	69/-
3,705,670	Stk. (£1)	Morgan Crucible A	46/-		10	10	4 7 0	46/-	43/6	45/-	34/-
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/6		5½	5½	6 5 9	18/6	17/6	18/-	17/-
2,200,000	Stk. (£1)	Murex	49/3	+1/-	17½	20	7 2 0	50/-	42/-	58/9	46/-
468,000	5/-	Ratcliffs (Great Bridge)	11/3xd		10 R	10	4 9 0	11/6	10/4½	11/1½	6/10½
234,960	10/-	Sanderson Bros. & Newbould ...	31/-	+1/-	20	27½D	6 9 0	31/-	27/9	27/3	24/6
1,365,000	Stk. (5/-)	Serck	20/4½	+4½d.	15	17½	3 13 6	20/4½	18/-	18/7½	11/-
6,698,586	Stk. (£1)	Stone-Platt Industries	49/9	+2/9	15	12½	6 0 6	49/9	43/3	45/6	22/6
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	17/-		5½	5½	6 9 6	17/-	15/10½	16/3	12/7½
18,255,218	Stk. (£1)	Tube Investments Ord.	84/3	+1/9	17½	15	4 3 0	84/3	72/-	86/-	48/4½
41,000,000	Stk. (£1)	Vickers	34/4½	+1/4½	10	10	5 16 3	37/-	30/6	36/3	28/9
750,000	Stk. (£1)	Ditto Pref. 5%	14/6		5	5	6 18 0	15/0¾	14/6	15/9	14/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	21/6		*5	*5	7 3 3A	22/7½	21/6	23/-	21/3
2,200,000	1	Ward (Thos. W.), Ord.	87/6		20	15	4 11 6	87/6	83/6	87/3	70/9
2,666,034	Stk. (£1)	Westinghouse Brake	44/-	+6d.	10	10	4 11 0	47/-	39/9	46/6	32/6
225,000	2/-	Wolverhampton Die-Casting ...	10/3		30	25	5 17 0	10/6	8/8½	10/1½	7/-
591,000	5/-	Wolverhampton Metal	28/6	+4/6	27½	27½	4 16 6	28/6	21/6	22/9	14/9
78,465	2/6	Wright, Bindley & Gell	6/6		20	20	7 13 9	6/7½	4/11½	5/4½	2/9
124,140	1	Ditto Cum. Pref. 6%	13/9		6	6	8 14 6	13/9	13/6	13/-	11/3
150,000	1/-	Zinc Alloy Rust Proof	3/-		27	40D	9 0 0	3/-	2/9	3/1½	2/7½

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting **Shares of no Par Value. ‡ and 100% Capitalized Issue. ●The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. Y Calculated on 11½% dividend. ‖Adjusted to allow for capitalization issue. E for 15 months. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. ϕ And 100% capitalized issue. X Calculated on 17½%. C Paid out of Capital Profits. E and 50% capitalized issue in 7% 2nd Pref. Shares. P Interim dividend since reduced. § And Special distribution of 2½% free of tax. R And proposed 33⅓% capitalized issue in 8% Maximum Ordinary 5/- Stock Units.

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ST. HELENS, LANCASHIRE.
Tel.: St. Helens 7508. [0020

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